GENERAL BOARD OF HEALTH.

MEDICAL COUNCIL.

APPENDIX TO REPORT

OF THE

COMMITTEE FOR SCIENTIFIC INQUIRIES

IN RELATION TO

THE CHOLERA-EPIDEMIC OF 1854.

Presented to both Houses of Parliament by Her Majesty's Command.

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No. I.

Report upon the Meteorology of London, in relation to the Cholera-Epidemic of 1853–4. By Mr. Glaisher.

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No. I.

Report upon the Meteorology of London, in relation to the Cholera-Epidemic of 1853–4. By Mr. Glaisher.

SIR, Lewisham, March 8, 1855.

IN the Report upon the Meteorology of London, and its relation to the epidemic of Cholera, which I have the honour to submit to you, I have endeavoured to carry out the different investigations you considered desirable, as sketched in your several letters to me.

The Observations were made by the gentlemen whose names appear in the Report; their reduction and formation into Tables, and the drawing of the Diagrams, were performed under the superintendence of Mr. William Richardson, the Assistant Secretary of the British Meteorological Society. All these duties were performed with care and ability.

I have the honour to be, Sir,

Your obedient servant,

JAMES GLAISHER.

Subjects of Investigation.

The determination of Atmospheric Pressure over the Metropolitan Districts.

The Maximum Temperature by Day.

The Minimum Temperature by Night.

The Daily Range of Temperature.

The Mean Temperature of the Air.

The Mean Temperature of the Thames Water.

The Mean Temperature of Evaporation.

The Mean Temperature of the Dew Point.

The Mean Elastic Force of Vapour.

The Mean Degree of Humidity.

The Mean Weight of Vapour in a certain mass of Air.

The Mean Weight of the same mass of Air under its Mean Temperature, Humidity, and Pressure.

The Amount and Distribution of Ozone.

The Amount and Distribution of Electricity.

The Fall of Rain.

The Direction, Force, and Velocity of the Wind.

The Comparison of the Meteorological Phenomena for London compared with those simultaneously observed at some towns in the country, and,

The Investigation into the Meteorology of the years 1832, 1849, and 1854 in relation to Cholera in the Metropolitan Districts.

A

An accurate determination of these elements was found essential to the prosecution of the inquiry, and it subsequently proved desirable to institute a careful comparison of each subject with its average values from a long series of years.

NAMES and POSITIONS OF METEOROLOGICAL STATIONS, and NAMES of OBSERVERS.

Name of Station.	Latitude.	Longitude.	Approx. Height above Sea.	Names of the Observers.
	° ′	° ′	Feet.	
Crystal Palace, Sydenham	51. 27 N.	0. 4 W.	300 ?	Under the superintendence of George Grove, Esq., secretary.
Lewisham - - -	51. 28	0. 1 W.	82	W. Richardson, Esq., Assistant Secretary, British Meteorological Society.
Royal Observatory -	51. 28	0. 0	159	The Astronomer Royal.
Bexley Heath - -	51. 28	0. 10 E.	210	Flaxman Spurrell, Esq., M.R.C.S.
Brixton Road - -	51. 28	0. 6 W.	350	Francis Boyle Garty, Esq., M.R.C.S.
Camberwell - - -	51. 28	0. 5	15	William Scarle, Esq.
Battersea - - -	51. 29	0. 10	15	James Griffin, Esq.
Dreadnought Hospital Ship - - -	51. 29	0. 1	20	Captain Sanders, R.N.
*Bermondsey - -	51. 29	..	0	—— Martin, Esq.
Millbank Prison - -	51. 29	0. 8	15	Mr. R. J. Gould, under the superintendence of Dr. Baly.
Consumption Hospital, Brompton - - -	51. 29	0. 10	20	Vertue Edwards, Esq., M.R.C.S.
General Board of Health, Whitehall.	51. 30	0. 7	20	J. F. Campbell, Esq., and John C. Hailes, Esq.
St. Thomas' Hospital -	51. 30	0. 5	60	R. D. Thomson, Esq.; M.D.; F.R.S., L. & E.; M.B.M.S.
Poplar - - - -	51. 30	0. 0	20	W. J. Bain, Esq, M.D.
Guildhall - - -	51. 30	0. 5	40	Frederick Singleton Knott, Esq.
General Registry Office, Somerset House.	51. 30	0. 7	30	William Clode, Esq., under the Superintendence of the Registrar General.
St. Giles' Workhouse -	51. 30	0. 8	20	William Bennett. Esq., M.D.
Chiswell Street Brewery	51. 30	0. 5	96	Walter Fletcher, Esq.
St. Mary's Hospital -	51. 30	0. 10	126	William Copney, Esq.
Bethnal Green - -	51. 31	0. 3	20	Thomas Austen, Esq.
St. John's Wood - -	51. 31	0. 11	150	George Leach, Esq., President B.M.S.
St. Pancras - -	51. 31	0. 8	40	Charles Worrell, Esq.
Highgate - - -	51. 32	0. 10	420	Dr. Sutherland, Inspector General.
Enfield Vicarage - -	51. 39 N.	0. 5 W.	100	Rev. J. M. Heath, M.A., M.B.M.S.

The instruments consisted of

A Dry Bulb Thermometer,
A Wet Bulb Thermometer,
A Maximum Thermometer,
A Minimum Thermometer,
Moffat's Ozone Test Papers,
Schonbein's Ozone Test Papers,

} at all the stations.

An Electrometer in addition at six stations.
A Barometer in addition at seven stations.
A Rain Gauge in addition at nine stations.

The instruments were all previously compared with standards, and their index errors exactly determined, under my own superintendence.

The stations at Sydenham, Lewisham, Greenwich, Bexley, Brixton, St. Thomas's Hospital, Chiswell Street, St. Mary's Hospital, St. John's Wood, and Enfield Vicarage, were already supplied with instruments; Dr. Baly at Millbank, the President of the Board of Health, and the Registrar General, furnished themselves with instruments for this inquiry, and the instruments were furnished by the Board of Health to Camberwell, Battersea, Dreadnought Hospital Ship, Bermondsey,* Brompton, Poplar, Guildhall, St. Giles, Bethnal Green, St. Pancras, and Highgate.

Plan of Observations.

To obtain a tolerable approximation to the laws of the distribution of temperature, humidity, &c., within a few weeks, it was essential that every precaution should be adopted to ensure the most perfect comparability of results. To this end the instruments selected were uniformly good, and were placed for the most part by myself at each station, in the best position the observer could command; personal instructions were given with regard to instruments and the method of recording observations, and were repeated till the observer had acquired the power of observing with accuracy.

It was desirable that the plan of observation should be the least onerous to give the required information. A plan of simultaneous observations I found to be incompatible with the various avocations of my corps of observers. For the same reason I was forced to content myself in some cases with one set of observations daily, but for the most part I succeeded in obtaining two, and in a few cases as many as three sets daily. The following Table shows the times of observation at the several stations.

Name of Station.	Times of Observation.
Crystal Palace - - -	9 a.m. and 3 p.m.
Lewisham - - - -	9 a.m. and 3 p.m.
Royal Observatory - - -	9 a.m. noon, 3 and 9 p.m.
Bexley Heath - - -	9 a.m. and 9 p.m.
Brixton Road - - -	11 a.m.
Camberwell - - - -	9 a.m. and 3 p.m.
Battersea - - - -	9 a.m. and 3 p.m.
Dreadnought Hospital Ship - -	9 a.m. 3 and 9 p.m.

* No observation was received from this most important station. I much regret that Mr. Martin did not signify to me his reluctance or inability to discharge the duties of an observer. I should have then taken steps to secure observations from this particular locality.

Name of Station.	Times of Observation.
Millbank Prison - - -	9 a.m. and 4 p.m.
Consumption Hospital, Brompton -	9 a.m. and 3 p.m.
General Board of Health, Whitehall -	10 a.m. and 4 p.m.
St. Thomas' Hospital - -	11 a.m. and 3 p.m.
Poplar - - - -	9 a.m. and 5 p.m.
Guildhall - - - -	11 a.m. and 4 p.m.
General Registry Office, Somerset House - - - -	11 a.m. and 3 p.m.
St. Giles' Workhouse - - -	10 a.m. and 3 p.m.
Chiswell Street Brewery - -	9 a.m. and 3 p.m.
St. Mary's Hospital - - -	9 a.m. and 3 p.m.
Bethnal Green - - -	9 a.m. and 3 p.m.
St. John's Wood - - -	9 a.m. and 5 p.m.
St. Pancras - - - -	9 a.m. and 3 p.m.
Highgate - - - -	9 a.m. and 3 p.m.
Enfield Vicarage - - -	9 a.m.

Reduction of the Observations.

At the end of each week the observations were forwarded to me. The first step in their reduction was the examination of every reading in comparison with all others taken at about the same time; the second was the application of index errors; corrections for diurnal range; and all necessary corrections and calculations to deduce the mean daily value of each element of investigation. The weekly means of the daily values were next taken, and the following Tables formed.

I will now proceed to discuss the results of each element separately.

Atmospheric Pressure.

Table I. contains the weekly means of the observed readings of the barometer, corrected for capillarity, index errors, diurnal range, and reduced to the temperature of 32°.

TABLE I.—Weekly Means of Atmospheric Pressure.

Week ending

Name of Station.	July 8	July 15	July 22	July 29	August 5	August 12	August 19	August 26	September 2	September 9	September 16	September 23	September 30
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Lewisham - -	29·698	29·780	30·035	30·079	29·792	29·926	29·888	29·985	30·281	33·250	29·924	30·028	30·161
Royal Observatory	29·618	29·702	29·954	29·990	29·701	29·846	29·813	29·915	30·212	30·106	29·857	29·972	30·076
Bexley Heath -	..	..	..	..	..	..	..	..	30·145	30·103	29·795	29·893	30·015
Brixton Road -	..	..	..	..	..	..	..	..	30·044	29·929	29·968	29·775	29·939
St. Thomas' Hosp.	29·692	29·777	30·031	30·081	29·788	29·930	29·858	30·004	30·299	30·246	29·932	30·038	30·184
St. Mary's Hosp. -	29·625	29·703	29·984	30·007	29·727	29·881	29·841	29·943	30·205	30·194	29·849	29·981	30·120
St. John's Wood -	29·585	29·680	29·932	29·971	29·683	29·825	29·794	29·895	30·210	30·163	29·809	..	..
Enfield Vicarage -	29·640	29·721	29·981	30·036	29·731	29·894	..	29·903	..	..	29·954	29·965	30·121

Name of Station.	October 7	October 14	October 21	October 28	November 4	November 11	November 18	November 25	December 2	December 9	December 16	December 23	December 30
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Lewisham - -	29·801	30·105	29·595	29·575	30·175	30·183	29·549	29·481	29·601	29·743	29·963	29·694	30·037
Royal Observatory	29·710	30·036	29·504	29·517	30·101	30·114	29·467	29·397	29·519	29·631	29·868	29·594	29·963
Bexley Heath -	29·636	29·967	29·419	29·450	30·057	30·044	29·370	..	..	..	..	29·565	29·910
Brixton Road -	29·552	29·910	29·377	29·422	30·002	30·057	29·310	29·328	..	..	..	..	..
St. Thomas' Hosp.	29·813	30·154	29·584	29·615	30·230	30·198	29·570	29·511	29·676	29·758	29·987	29·723	30·106
St. Mary's Hosp. -	29·735	30·051	29·532	29·525	30·128	30·152	29·472	29·418	29·536	29·668	29·895	29·625	29·976
St. John's Wood -	..	..	..	..	..	..	29·446	29·376	29·497	29·629	29·848	29·582	29·937
Enfield Vicarage -	29·751	30·055	29·555	29·601	30·141	30·133	29·495	..	29·528	29·676	29·880	29·592	29·965

By applying the correction for elevation, the next Table is formed.

TABLE II.—Weekly Means of Barometric Pressure corrected and reduced to Mean Sea-level.

Week ending

Name of Station.	July 8	July 15	July 22	July 29	August 5	August 12	August 19	August 26	September 2	September 9	September 16	September 23	September 30
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Lewisham - -	29·790	29·872	30·127	30·171	29·884	30·018	29·980	30·077	30·373	30·342	30·016	30·120	30·253
Royal Observatory	29·796	29·880	30·132	30·168	29·879	30·024	29·991	30·093	30·390	30·344	30·035	30·150	30·254
Bexley Heath -	..	..	..	..	..	..	..	..	30·381	30·339	30·031	30·129	30·251
St. Thomas' Hosp.	29·759	29·844	30·098	30·148	29·850	29·997	29·925	30·071	30·366	30·313	29·999	30·105	30·251
St. Mary's Hosp. -	29·766	29·844	30·125	30·132	29·868	30·022	29·982	30·084	30·346	30·335	29·990	30·122	30·261
St. John's Wood -	29·753	29·848	30·110	30·139	29·851	29·993	29·962	30·063	30·378	30·331	29·977	..	..
Enfield Vicarage -	29·752	29·833	30·093	30·148	29·843	30·006	..	30·015	..	..	30·066	30·077	30·233
Means - -	29·769	29·853	30·114	30·151	29·864	30·010	29·968	30·067	30·371	30·335	30·014	30·115	30·250

Name of Station.	October 7	October 14	October 21	October 28	November 4	November 11	November 18	November 25	December 2	December 9	December 16	December 23	December 30
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Lewisham - -	29·893	30·197	29·687	29·667	30·267	30·275	29·641	29·573	29·693	29·835	30·055	29·786	30·129
Royal Observatory	29·880	30·214	29·682	29·695	30·279	30·292	29·645	29·575	29·697	29·809	30·046	29·774	30·141
Bexley Heath -	29·872	30·203	29·655	29·686	30·293	30·280	29·606	..	..	..	..	29·801	30·146
St. Thomas' Hosp.	29·880	30·221	29·651	29·682	30·307	30·275	29·647	29·588	29·743	29·825	30·054	29·790	30·173
St. Mary's Hosp. -	29·876	30·192	29·672	29·666	30·269	30·293	29·613	29·559	29·677	29·809	30·036	29·766	30·117
St. John's Wood -	..	..	..	..	..	..	29·614	29·544	99·665	29·797	30·016	29·750	30·105
Enfield Vicarage -	29·863	30·167	29·667	29·713	30·253	30·245	29·607	..	29·640	29·788	29·992	29·702	30·077
Means - -	29·878	30·198	29·652	29·685	30·275	30·275	29·625	29·568	29·686	29·810	30·029	29·767	30·125

The numbers in the lower line show the weekly pressure of the atmosphere over the metropolitan districts at the level of the sea. They are not remarkable till the second week in August: the pressure then exceeded 30 inches, and, with the exception of a slight defect (0·032 in.) in the following week, it exceeded 30 inches in each succeeding week till the end of September. The pressure during the first and second weeks in September was remarkably high, exceeding 30½ inches in both weeks; it decreased in the third week, and increased in both of the following weeks. It was low in the last two weeks in October, very high in the first two weeks in November, low in the last two weeks, and afterwards variable.

By comparing the numbers at the several stations, it will be seen, as might have been expected over so small a space as the metropolis, that the atmosphere has been evenly distributed. It will, therefore, be necessary to trace the successive maxima and minima of atmospheric pressure from one station only. They are recorded in the following Table.

TABLE III.—Showing the successive Maxima and Minima Readings of the Barometer in London, at the Level of the Sea.

Month, Day, and Hour.		Readings of Barometer; successive Maxima and Minima.	Difference between successive Readings.	
			Increase.	Decrease.
1854:		in.	in.	in.
July 1	9 a.m.	29·927		
2	11 a.m.	30·015	·088	
4	3 p.m.	29·620		·395
8	noon	29·830	·210	
9	1 p.m.	29·787		·043
10	9 p.m.	29·977	·190	
12	9 a.m.	29·855		·122
13	noon	29·906	·051	
14	3 p.m.	29·790		·116
16	11 a.m.	30·148	·358	
18	3 p.m.	30·010		·138
22	9 a.m.	30·272	·262	
25	noon	30·100		·172
28	9 a.m.	30·260	·160	
31	9 p.m.	29·702		·558
Aug. 6	11 p.m	30·150	·448	
10	3 p.m.	29·845		·305
11	9 p.m.	30·027	·182	
14	9 a.m.	29·792		·235
18	9 p.m.	30·215	·423	
21	9 p.m.	29·810		·405
23	9 a.m.	30·195	·385	
24	3 p.m.	29·956		·239
28	9 a.m.	30·515	·559	
30	9 p.m.	30·187		·328
Sept. 3	9 a.m.	30·448	·261	

Table III.—Successive Maxima and Minima Readings, &c.—*cont.*

Month, Day, and Hour.	Readings of Barometer; successive Maxima and Minima.	Difference between successive Readings. Increase.	Decrease.
1854:	in.	in.	in.
Sept. 3 - 9 a.m. -	30·448		
4 - 3 p.m. -	30·370		·078
5 - noon -	30·503	·133	
9 - 3 p.m. -	30·228		·275
10 - 9 a.m. -	30·285	·057	
14 - 9 a.m. -	29·765		·520
15 - 9 a.m. -	30·033	·268	
16 - 9 p.m. -	29·858		·175
18 - noon -	30·190	·332	
20 - noon -	29·980		·210
22 - 9 a.m. -	30·398	·418	
24 - 1 p.m. -	30·107		·291
26 - 9 a.m. -	30·440	·333	
29 - 3 p.m. -	30·147		·293
Oct. 1 - 10 a.m. -	30·276	·129	
3 - 9 a.m. -	29·805		·471
3 - 9 p.m. -	29·970	·165	
5 - 3 p.m. -	29·570		·400
7 - 9 p.m. -	30·138	·568	
9 - 9 a.m. -	29·760		·378
13 - 9 a.m. -	30·615	·855	
18 - 9 a.m. -	29·282		1·333
19 - noon -	29·842	·560	
20 - 3 p.m. -	29·420		·422
21 - 9 p.m. -	29·687	·267	
25 - 3 p.m. -	29·047		·640
27 - 9 p.m. -	30·406	1·359	
29 - 10 a.m. -	30·182		·224
29 - 9 p.m. -	30·352	·170	
31 - 9 a.m. -	30·125		·227
Nov. 1 - 9 p.m. -	30·462	·337	
5 - 10 a.m. -	30·063		·399
7 - noon -	30·590	·527	
11 - 9 a.m. -	30·079		·511
12 - 3 p.m. -	30·310	·231	
16 - 9 a.m. -	29·058		1·252
20 - 9 a.m. -	30·215	1·157	
22 - 3 p.m. -	28·988		1·227
27 - 9 p.m. -	30·110	1·122	
29 - 9 p.m. -	29·259		·851
30 - 9 a.m. -	29·584	·325	
30 - 9 p.m. -	29·250		·334
Dec. 2 - 9 p.m. -	30·087	·837	
3 - 9 p.m. -	29·832		·255
4 - noon -	30·113	·281	
5 - 9 p.m. -	29·385		·728

TABLE III.—Successive Maxima and Minima Readings, &c.—*cont.*

Month, Day, and Hour.	Readings of Barometer; successive Maxima and Minima.	Difference between successive Readings. Increase.	Difference between successive Readings. Decrease.
1854 :	in.	in.	in.
Dec. 5 - 9 p.m. -	29·385		
		·863	
7 - 9 p.m. -	30·248		
			·750
9 - 9 a.m. -	29·498		
		·624	
10 - 10 p.m. -	30·122		
			·148
11 - 9 p.m. -	29·974		
		·296	
13 - 9 a.m. -	30·270		
			·272
14 - 3 p.m. -	29·998		
		·095	
14 - 9 p.m. -	30·093		
			·309
16 - 9 a.m. -	29·784		
		·235	
17 - 10 a.m. -	30·019		
			·982
18 - 9 a.m. -	29·037		
		·774	
19 - noon -	29·818		
			·350
20 - 9 a.m. -	29·461		
		·726	
21 - 9 a.m. -	30·187		
			·449
22 - 9 p.m. -	29·738		
		·245	
23 - 9 a.m. -	29·983		
			·323
25 - 11 a.m. -	29·660		
		·897	
29 - 9 p.m. -	30·557		

The numbers in the second column of this Table give the reading of the barometer on the passage of the anterior and posterior troughs, as well as the crest of every wave of air that passed over the metropolis from July to December; the numbers in the third column show the difference of readings between the passage of the anterior trough and the crest, and those in the last, the difference between the crest and posterior trough. The difference between the numbers in the first column shows the rapidity of the motion of the wave.

In considering the observations, nothing very peculiar presents itself till towards the end of August, till which time a number of small waves only had passed. The readings were remarkable from the end of August till September 10, indicating a dense atmosphere. On August 28, September 3, and September 5, the crest of three waves passed over London, and the pressure was about 30½ inches at each transit. Another remarkable instance of continuous high readings took place between September 22 and October 1. In October, the maximum pressure during the period took place, viz., 30·615 inches. The anterior trough of this wave passed on the 9th, the crest on the 13th, and the posterior trough on the 18th; at the latter time, the barometer reading was 1·333 inches less than on the passage of the crest. Between October 25 and 27 the most rapid change of reading within the period of observation took place, amounting to 1·359 inches within 2¼ days.

From November 12 to the end of the month large variations of reading were more continuous than at any other time; and in December the variations of pressure were frequent, but not to large amounts.

The most remarkable waves within the period of observation were those which took place in November, the crests of which passed on the 12th, 20th, and 27th; the readings were 30·31 inches, 30·21 inches, and 30·11 inches respectively; each successive maximum being smaller than the preceding. The trough of these waves passed on the 16th, 22d, and 29th; the readings were 29·06 inches, 28·99 inches (which was the lowest reading within the period of observation), and 29·26 inches successively.

It is now necessary to compare the observed pressure with its normal value. For this purpose I have several series of observations, all agreeing with each other, but two only which extend so far back as 1841, viz., those of George Leach, Esq., and the Royal Observatory, Greenwich. The following Table shows the mean monthly return for a period of 14 years as determined from these stations:—

TABLE IV.—MEAN MONTHLY READING of the BAROMETER at LONDON, at the Level of the Sea, from the Year 1841 to 1854.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1841	29·875	29·870	29·957	29·904	29·904	29·974	29·889	29·941	29·797	29·609	29·845	29·747
1842	30·074	30·050	29·920	30·087	29·955	30·074	29·993	30·042	29·888	30·022	29·772	30·180
1843	29·845	29·646	29·931	29·860	29·837	29·873	29·999	29·992	30·190	29·777	29·891	30·418
1844	30·064	29·671	29·883	30·173	30·118	29·987	29·926	29·850	30·054	29·735	29·863	30·058
1845	29·877	30·013	29·968	29·869	29·885	29·947	29·942	29·902	29·974	30·020	29·748	29·831
1846	29·844	30·022	29·828	29·762	29·952	30·039	29·930	29·950	29·997	29·689	29·994	29·870
1847	29·941	29·955	30·055	29·826	29·937	29·878	30·097	30·049	29·998	29·976	30·078	29·951
1848	29·989	29·690	29·678	29·762	30·099	29·815	30·009	29·905	30·005	29·819	29·958	29·980
1849	29·944	30·279	30·088	29·690	29·939	30·041	29·962	30·014	29·940	29·917	29·916	29·968
1850	30·027	30·001	30·212	29·767	29·837	30·059	29·962	29·960	30·103	29·854	29·901	30·087
1851	29·815	30·064	29·773	29·899	30·064	30·068	29·881	30·063	30·198	29·899	29·954	30·308
1852	29·762	30·030	30·180	30·118	29·959	29·733	30·030	29·822	29·912	29·860	29·638	29·754
1853	29·743	29·698	29·953	29·883	29·927	29·902	29·901	29·966	30·006	29·731	30·014	29·977
Means -	29·908	29·922	29·956	29·892	29·959	29·961	29·963	29·958	30·005	29·839	29·898	30·010
1854 - -	29·791	30·214	30·359	30·158	29·840	29·908	29·980	30·062	30·204	29·897	29·901	29·941
Diff. from average	− 0·117	+ 0·292	+ 0·403	+ 0·266	− 0·119	− 0·053	+ 0·017	+ 0·104	+ 0·199	+ 0·058	+ 0·003	− 0·069

The sign − implies below the average, and the sign + denotes above the average.

The numbers in the lowest line show the monthly difference of atmospheric pressure from the average in the year 1854. From them we learn that the pressure was in defect in January, May, June, and December; was near its average value in July and November, when it was slightly in excess; it was in excess in all the remaining months.

In February the excess was large, and the reading was greater than in any February in the series, except 1849. In March the excess was very large, and the reading exceeds that of any March in the above series.

In April the excess was large, and the reading was exceeded in one instance only, viz., in April 1844. In August the excess was large, but there are three instances in the Table with readings of nearly the same value, viz., in 1842, 1849, and 1851.

In September the excess was large, and the reading exceeded that of September in the series.

The mean reading for the year 1854 was 30·021 inches, exceeding the average by 0·082 inches.

Temperature of the Air.

The thermometers employed in determining the temperature and humidity of the air were made by Messrs. Negretti and Zambra, and, as before stated, were all carefully compared with standards, and their errors determined.

The mean daily temperature of the air was found from the mean of the observations of the dry-bulb thermometer, corrected for diurnal range;* and a second mean was found from the readings of the maximum and minimum thermometers, also corrected by a quantity given in the same paper. The adopted mean temperature for each day was then determined by combining these two values, and giving them weights proportional to the number of observations from which they respectively derived.

The mean of these was taken weekly; their results are shown in the annexed Table.

* The quantities required to perform these corrections will be found in a paper by myself, published in the "Philosophical Transactions," Part I. 1848.

TABLE V.—Weekly Mean Temperature of the Air.

Name of Station.	Week ending: July				August				September					October				November				December				
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Sydenham	..	..	..	..	..	..	..	..	..	..	59·9	55·4	54·6	54·1	50·2	45·1	44·5	48·9	41·8	40·6	35·8	..	41·9	44·0	..	37·3
Lewisham	58·0	56·1	63·8	66·3	59·9	60·4	59·7	61·4	65·0	60·6	60·4	57·3	55·5	54·8	51·7	46·9	45·4	50·2	42·3	41·2	36·6	39·1	42·0	41·9	40·0	40·1
Royal Observatory	56·9	56·4	63·2	64·9	58·5	60·1	59·9	61·2	65·1	59·2	60·7	57·1	55·2	53·6	50·9	46·5	44·9	49·7	42·2	40·9	36·5	38·4	42·2	42·8	40·5	39·8
Bexley Heath	..	..	..	..	..	..	..	..	63·6	57·6	59·8	58·6	55·2	55·3	51·6	47·1	45·3	49·3	41·9	42·2	36·4	42·0	42·7	43·1	41·7	39·4
Brixton Road	..	..	..	..	..	..	..	..	67·3	61·3	64·5	57·2	58·2	55·0	52·4	46·2	46·4	50·4	44·5	43·0	37·5	..	..	..	..	..
Camberwell	..	..	..	..	..	..	..	..	..	..	61·1	57·0	54·6	54·6	52·5	47·0	46·5	49·6	43·3	..	..	43·0	42·8	43·7	39·0	..
Battersea	..	..	..	..	..	..	..	..	..	..	..	60·9	55·0	54·7	53·3	46·1	43·2	47·0	41·3	41·1	36·0	40·0	..	..	..	..
Dreadnought	59·0	58·6	65·1	65·4	58·6	62·0	59·7	61·1	..	59·6	61·1	60·8	56·0	56·0	53·4	50·3	49·1	53·3	47·2	45·2	41·9	41·6	43·4	45·6	43·6	41·0
Millbank	..	..	..	..	..	..	..	..	..	..	..	59·9	55·5	54·8	52·2	47·2	45·9	50·1	43·7	42·4	38·1	39·1	44·4	43·3	41·8	40·5
Brompton	..	..	..	..	..	..	..	..	..	..	..	56·8	54·1	54·6	51·4	47·1	44·5	48·9	43·1	42·3	38·0	38·6	43·5	44·1	43·7	..
Board of Health	..	..	..	..	..	..	..	..	..	60·9	61·3	59·1	54·8	54·8	52·0	46·6	44·5	49·8	43·0	42·7	37·7	39·8	42·5	44·0	41·3	38·3
St. Thomas' Hosp.	57·8	56·6	65·6	67·7	59·8	59·6	62·0	62·8	64·4	60·7	61·2	58·2	56·0	54·1	51·9	46·9	45·5	50·7	43·6	42·2	38·0	38·9	43·5	42·8	41·2	40·6
Poplar	..	..	..	..	..	..	..	..	..	..	63·0	59·3	54·4	54·6	51·8	46·7	45·3	48·8	42·8	42·0	37·8	38·7	41·6	44·4	40·3	39·8
Guildhall	..	..	..	..	..	..	..	..	..	..	..	..	54·0	56·3	53·2	47·5	46·0	49·8	44·5	43·4	37·5	40·1	..	..	..	..
Somerset House	..	..	..	..	..	..	..	..	..	..	62·7	56·6	55·1	55·4	52·6	48·7	45·6	51·5	44·5	43·1	37·5	39·7	44·2	43·8	41·1	41·4
St. Giles	..	..	..	..	..	..	..	..	..	..	..	57·9	56·5	55·8	53·4	47·2	45·6	54·1	43·4	43·0	..	..	..	..	..	..
Chiswell Street	..	..	..	..	..	..	..	..	68·0	63·5	63·1	59·0	58·0	..	54·5	49·8	48·1	51·4	..	..	..	..	..	..	..	..
St. Mary's Hosp.	57·1	57·2	61·2	68·0	58·8	61·2	59·4	60·9	65·5	62·8	61·7	57·8	57·8	56·1	53·0	47·6	46·0	51·9	43·5	42·5	37·9	39·0	43·8	43·4	41·1	41·2
Bethnal Green	..	..	..	..	..	..	..	..	..	..	..	58·7	56·4	56·0	52·4	47·2	45·5	50·9	42·9	42·3	37·3	39·9	43·4	45·3	..	..
St. John's Wood	57·8	56·1	62·9	65·3	57·8	60·2	58·9	60·0	64·4	60·7	59·4	..	..	..	..	..	..	..	..	41·0	36·5	37·5	41·8	41·7	39·9	38·6
St. Pancras	..	..	..	..	..	..	..	..	..	..	..	54·7	52·8	53·8	50·6	46·7	42·2	50·0	44·7	42·9	..	..	..	..	..	..
Highgate	..	..	..	..	..	..	..	..	..	..	60·4	58·7	58·3	55·2	53·1	47·0	46·7	49·9	43·0	40·6	36·3	37·9	42·2	42·4	..	39·3
Enfield Vicarage	58·3	56·4	61·3	64·9	60·1	58·0	..	60·3	..	..	55·4	58·4	52·4	53·0	50·7	45·0	45·3	46·0	41·4	40·4	..	38·1	41·4	40·3	38·5	38·2
Means	57·8	56·8	63·3	66·1	59·1	60·2	59·9	61·1	65·4	60·7	61·0	58·1	55·5	54·0	52·2	47·1	45·5	50·3	43·5	42·8	37·5	39·6	42·7	43·3	41·0	39·7
Mean temperature as found from:— Sydenham, Lewisham, Bexley Heath, Royal Observ., St. John's Wood, St. Pancras, Highgate, Enfield	57·7	56·2	62·8	65·8	59·1	59·7	59·5	60·7	64·5	59·5	59·4	57·2	54·9	54·3	51·3	46·3	44·9	49·1	42·8	41·2	36·3	38·9	42·1	42·4	40·2	39·0

The numbers in this Table show the weekly distribution of temperature over the Metropolis. In the last line but one, are given the mean results of all the stations; they show the temperature in each week of the Metropolitan districts.

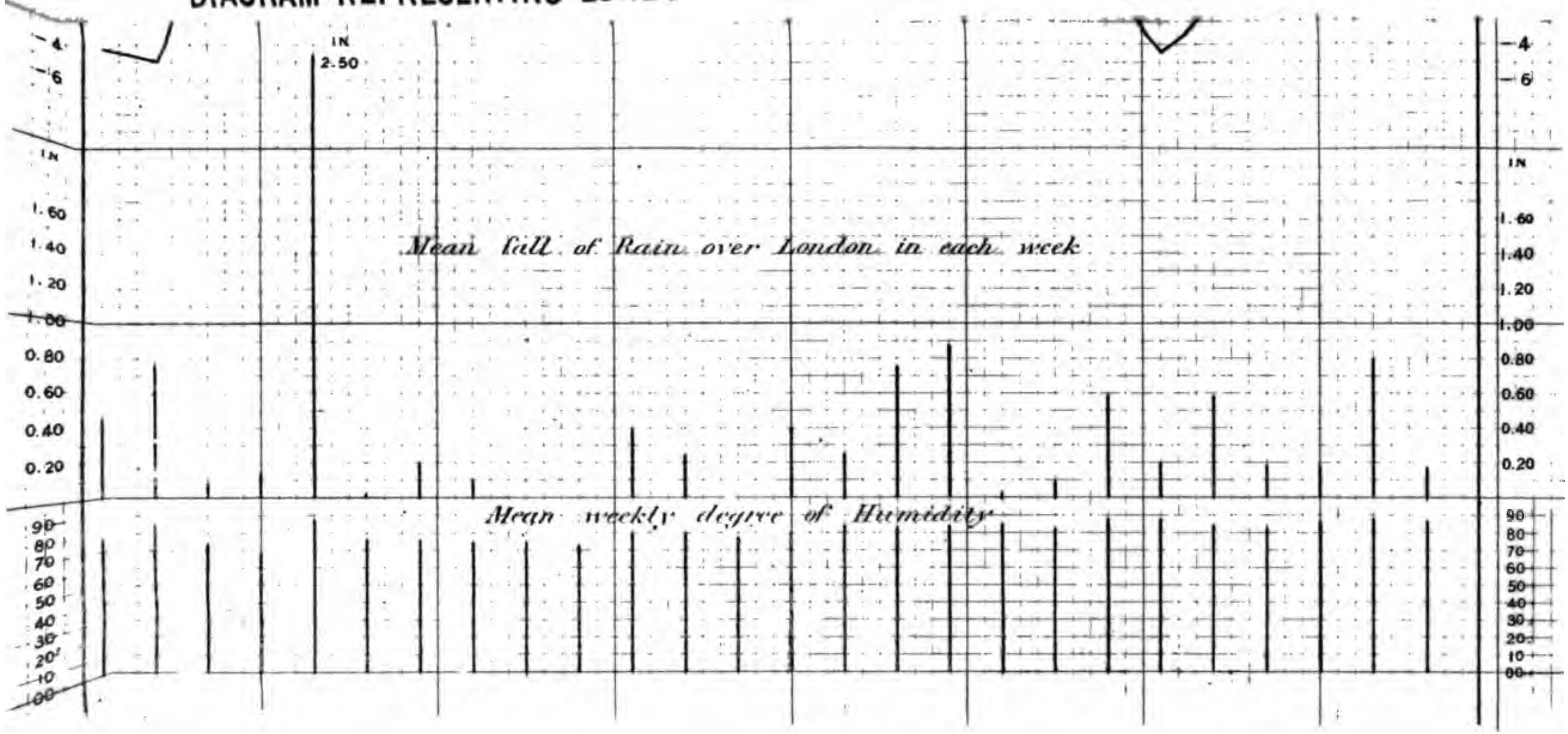
By comparing the individual results with these values, it will be seen that generally the temperature at the central stations has been somewhat higher, and those at the outlying stations somewhat lower than the mean.

In the last line of this Table are given the mean results of those stations situated both north and south of London, and which I found to agree well with each other. They may be considered as the mean weekly temperature of the Metropolitan districts, free from the effects of the river Thames and all Metropolitan influences. The result of this comparison is shown in the following Table:—

TABLE VI.—Showing the Excess of Temperature at the Central Stations over the Means at the Boundary Stations.

Name of Station.	Week ending																									
	July				August				September					October				November				December				
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Brixton Road -	..	..	..	..	..	..	..	..	+2·8	+1·8	+5·1	0·0	+3·3	+0·7	+1·1	−0·1	+1·5	+1·3	+1·7	+1·8	+1·2	..	..	..	..	..
Camberwell -	..	..	..	..	..	..	..	..	..	..	+1·7	−0·2	−0·3	+0·3	+1·2	+0·7	+1·6	+0·5	+0·5	..	..	+4·1	+0·7	+1·3	−1·2	..
Battersea - -	..	..	..	..	..	..	..	..	..	..	..	+3·7	+0·1	+0·4	+2·0	−0·2	−1·7	−2·1	−1·5	−0·1	−0·3	+1·1	..	..	..	..
Dreadnought -	+1·3	+2·4	+2·3	−0·4	−0·5	+2·3	+0·2	+0·4	..	+0·1	+1·7	+3·6	+1·1	+1·7	+2·1	+4·0	+4·2	+4·2	+4·4	+4·0	+5·6	+2·7	+1·3	+3·2	+3·4	+2·0
Millbank - -	..	..	..	..	..	..	..	..	..	..	..	+2·7	+0·6	+0·5	+0·9	+0·9	+1·0	+1·0	+0·9	+1·2	+1·8	+0·2	+2·3	+0·9	+1·6	+1·5
Brompton - -	..	..	..	..	..	..	..	..	..	..	..	−0·4	−0·8	+0·3	+0·1	+0·8	−0·4	−0·2	+0·3	+1·1	+1·7	−0·3	+1·4	+1·7	+3·5	..
Board of Health -	..	..	..	..	..	..	..	..	..	+1·4	+1·9	+1·9	−0·1	+0·5	−0·7	+0·3	−0·4	+0·7	+0·2	+1·5	+1·4	+0·9	+0·4	+1·6	+1·1	−0.7
St. Thomas' Hosp.	+0·1	+0·4	+2·8	+1·9	+0·7	−0·1	+2·5	+2·1	−0·1	+1·2	+1·8	+1·0	+1·1	−0·2	+0·6	+0·6	+0·6	+1·6	+0·8	+1·0	+1·7	0·0	+1·4	+0·4	+1·0	+1·6
Poplar - - -	..	..	..	..	..	..	..	..	..	..	+3·6	+2·1	−0·5	+0·3	+0·5	+0·4	+0·4	−0·3	0·0	+0·8	+1·5	−0·2	−0·5	+2·0	+0·1	+0·8
Guildhall - -	..	..	..	..	..	..	..	..	..	..	..	..	−0·9	+2·0	+1·9	+1·2	+1·1	+0·7	+1·7	+2·2	+1·2	+1·2	..	..	..	..
Somerset House -	..	..	..	..	..	..	..	..	..	..	+3·3	−0·6	−0·2	+1·1	+1·3	+2·4	+0·7	+2·4	+1·7	+1·9	+1·2	+0·8	+2·1	+1·4	+0·9	+2·4
St. Giles' - -	..	..	..	..	..	..	..	..	..	..	..	+0·7	+1·6	+1·5	+2·1	+0·9	+0·7	+5·0	+0·6	+1·8	..	..	..	..	..	..
Chiswell Street -	..	..	..	..	..	..	..	..	+3·5	+4·0	+4·0	+1·8	+3·1	..	+3·2	+3·5	+3·2	+2·3	..	..	..	..	..	..	..	..
St. Mary's Hosp. -	−0·6	+1·0	−1·6	+2·2	−0·3	+1·5	−0·1	+0·2	+1·0	+3·3	+2·3	+0·6	+2·9	+1·8	+1·7	+1·3	+1·6	+2·8	+0·7	+1·3	+1·6	+0·1	+1·7	+1·0	+0·9	+2·2
Bethnal Green -	..	..	..	..	..	..	..	..	..	..	..	+1·5	+1·5	+1·7	+1·1	+0·9	+0·6	+1·8	+0·1	+1·1	+1·0	..	..	..	..	..
Means - -	+0·3	+1·3	+1·2	+1·2	0·0	+1·2	+0·9	+0·9	+1·8	+2·0	+2·8	+1·3	+0·8	+0·8	+1·3	+1·2	+0·9	+1·4	+0·9	+1·5	+1·7	+1·0	+1·2	+1·5	+1·3	+1·4

DIAGRAM REPRESENTING LONDON WEEKLY METEOROLOGICAL PHENOMENA



The black line indicates the boundary stations and the dotted line the central stations.

From the prevalence of + signs in this Table, it will be seen that London temperature has been higher than that of the country, and, by reference to the numbers, that the greatest excesses have occurred during the first three weeks in September. The mean excesses for the three months ending November 25 were,—

Brixton - - - - -	1°·7
Camberwell - - - -	0·7
Battersea - - - - -	0·0
Dreadnought - - - -	3·1
Millbank - - - - -	1·2
Brompton - - - - -	0·3
Board of Health - - - -	0·8
St. Thomas's Hospital - - -	0·9
Poplar - - - - -	0·8
Guildhall - - - - -	1·2
Somerset House - - -	1·5
St. Giles - - - - -	1·8
Chiswell Street - - - -	3·2
St. Mary's Hospital - - -	1·7
Bethnal Green - - - -	1·1

The greatest of these, 3·1° and 3·2°, took place at the Dreadnought Hospital Ship and at Chiswell Street. The mean of all for the month of September, October, and November, was 1·5°.

Some part of these excesses, however, are due to difference of elevation. The mean height of the boundary stations is about 200 feet, whilst that of the central stations is about 25 feet. We have therefere to lessen all the above excesses for the difference of level at the rate of 0·1° for every difference of 29 feet, or by 0·6° to determine the true excess of London temperature over that of the country. The numbers in the lower line of Table VI. show the weekly excess of London temperature, uncorrected for difference of elevation. The mean of all is 1·2°, and, corrected for difference of level, becomes 0·6°, which is the whole effect of all local causes in London to raise its mean temperature.*

Next in order of inquiry is the comparison of the observed temperatures with their normal values. The absolute mean daily temperatures are known at Greenwich from a series of observations made during 38 years. The daily mean temperatures from July 1

* This result is in accordance with that found by me in discussing London temperature in comparison with that of the country, in a paper published in the "Philosophical Transactions," Part XI., for 1850. In this paper I came to the conclusion "that those parts of London situate near the river Thames are somewhat warmer upon the whole year than the country, but that those parts of London which are situated at some distance from the river do not enjoy higher temperature than those due to their latitudes.

to December 30, deduced from that series, are given in the following Table :—

TABLE VII. — AVERAGE MEAN DAILY TEMPERATURE of the AIR at GREENWICH.

Days of the Month.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°
1	61·8	62·2	58·9	53·3	46·3	41·7
2	62·0	62·2	58·7	53·1	46·1	41·6
3	62·1	62·1	58·5	52·8	45·9	41·5
4	62·2	62·1	58·4	52·6	45·7	41·4
5	62·3	62·1	58·2	52·4	45·4	41·2
6	62·2	62·0	58·0	52·2	45·2	41·1
7	62·1	62·0	57·9	52·0	44·9	41·0
8	62·0	61·9	57·7	51·7	44·7	40·8
9	61·9	61·8	57·5	51·5	44·5	40·7
10	61·8	61·7	57·4	51·2	44·2	40·6
11	61·8	61·7	57·2	51·0	44·0	40·5
12	61·9	61·6	57·0	50·8	43·7	40·3
13	62·0	61·4	56·8	50·6	43·4	40·2
14	62·1	61·3	56·7	50·4	43·2	40·0
15	62·1	61·2	56·5	50·2	42·9	39·8
16	62·1	61·1	56·3	50·0	42·7	39·6
17	62·1	61·0	56·1	49·7	42·5	39·4
18	62·0	60·8	55·9	49·5	42·4	39·2
19	61·9	60·7	55·7	49·2	42·2	39·1
20	61·9	60·6	55·5	49·0	42·0	38·9
21	61·8	60·4	55·4	48·8	41·9	38·7
22	61·8	60·3	55·2	48·7	41·8	38·5
23	61·8	60·2	55·0	48·4	41·7	38·4
24	61·9	60·0	54·8	48·2	41·6	38·2
25	61·9	59·9	54·7	47.9	41·7	38·0
26	62·0	58·8	54·4	47·7	41·8	37·8
27	62·1	59·6	54·2	47·5	41·9	37·6
28	62·2	59·5	54·0	47·2	41·9	37·4
29	62·2	59·3	52·7	46·9	41·9	37·2
30	62·2	59·2	53·5	46·7	41·8	37·0
31	62·2	59·0		46·5		36·7

As before stated, the mean temperature of every day was determined for every station, and compared with the normal temperature for the same day, found from the numbers in the preceding Table, by the application of a correction for difference of elevation at the rate of 1° for a difference of elevation of 290 feet, and in this way the departure of the temperature from the average on every day for every station was found. The results of the weekly means of these numbers are contained in the following Table :—

TABLE VIII.—Weekly Mean of Air Temperature, Difference from Average of Week.

Name of Station.	Week ending																									
	July				August				September					October				November				December				
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Sydenham	..	..	..	..	..	..	..	..	..	..	+3·5	−0·5	+0·9	+2·0	−0·4	−3·9	−2·9	+3·1	−2·4	−1·9	−5·5	..	+1·3	+4·4	..	+0·2
Lewisham	−4·7	−5·9	+1·9	+4·3	−2·3	−1·4	−1·4	+1·2	+5·9	+2·6	+3·6	+1·8	+1·3	+2·2	+0·7	−2·6	−2·5	+3·9	−2·4	−1·8	−5·2	−2·7	+0·9	+1·8	+1·1	+2·5
Royal Observatory	−5·1	−5·5	+1·3	+2·9	−3·2	−1·7	−1·2	+1·1	+5·9	+1·1	+3·8	+1·5	+1·0	+1·0	−0·1	−3·0	−3·1	+3·4	−2·5	−2·1	−5·3	−3·4	+1·1	+2·7	+1·6	+2·2
Bexley Heath	..	..	..	..	..	..	..	..	+4·6	+0·1	+3·4	+3·6	+1·5	+3·2	+1·1	−2·8	−2·2	+3·5	−2·6	−0·6	−5·2	+0·4	+1·8	+3·2	+3·0	+2·0
Brixton Road	..	..	..	..	..	..	..	..	+8·8	+4·2	+8·4	+2·4	+4·8	+4·3	+2·2	−1·4	−1·9	+4·2	+0·5	+0·7	−3·6	..	..	..	..	..
Camberwell	..	..	..	..	..	..	..	..	..	..	+3·9	+1·2	+0·1	+1·5	+1·0	−2·9	−1·9	+2·7	−1·9	..	..	+0·7	+1·2	+3·1	−0·4	..
Battersea	..	..	..	..	..	..	..	..	..	..	..	+5·3	+1·1	+1·6	+1·9	−3·7	−4·4	+0·3	−3·9	−2·4	−6·3	−2·3	..	..	..	..
Dreadnought	−3·5	−3·7	+2·8	+3·0	−4·0	−0·2	−1·8	+0·4	..	+1·1	+3·7	+4·9	+1·4	+3·0	+1·8	+0·5	+0·5	+6·4	+2·0	+1·7	−0·4	−0·7	+1·8	+5·0	+4·2	+2·9
Millbank	..	..	..	..	..	..	..	..	..	..	..	+3·8	+0·9	+1·6	+0·7	−2·7	+2·4	+3·2	−1·5	−1·1	−4·2	−3·2	+2·8	+2·7	+2·4	+2·4
Brompton	..	..	..	..	..	..	..	..	..	..	..	+0·9	−0·5	+1·5	+0·1	−2·8	−3·8	+2·1	−2·1	−1·2	−4·3	−3·7	+1·8	+3·5	+4·3	..
Board of Health	..	..	..	..	..	..	..	..	..	+2·3	+3·9	+2·2	+0·3	+1·7	+0·6	−2·9	−3·8	+3·1	−2·2	−0·8	−4·5	−2·5	+0·9	+3·4	+1·9	+0·2
St. Thomas' Hosp.	−4·6	−5·6	+3·4	+5·4	−2·7	−2·5	−0·6	+2·3	+5·2	+2·2	+3·9	+2·2	+0·7	+0·9	+0·5	−2·9	−2·8	+3·7	−1·4	−1·1	−4·1	−3·2	+2·1	+2·4	+2·0	−2·7
Poplar	..	..	..	..	..	..	..	..	..	..	+5·7	+4·8	−0·1	+0·8	+0·3	−3·2	−3·3	+1·9	−2·4	−1·5	−4·5	−3·6	0·0	+3·8	+0·9	+1·7
Guildhall	..	..	..	..	..	..	..	..	..	..	..	..	−0·6	+3·3	+1·8	−2·3	−2·3	+3·0	−0·7	−0·1	−4·8	−2·2	..	..	..	..
Somerset House	..	..	..	..	..	..	..	..	..	..	+5·7	+4·7	+0·9	+2·3	+1·2	−2·4	−2·6	+4·8	−0·7	−0·4	−4·8	−2·6	+2·6	+3·2	+1·7	+3·3
St. Giles'	..	..	..	..	..	..	..	..	..	..	..	+2·1	+2·0	+2·8	+0·9	−2·6	−2·6	+3·9	−1·8	−0·5	..	..	..	..	..	..
Chiswell Street	..	..	..	..	..	..	..	..	+8·7	+5·3	+4·7	+4·1	+3·6	..	+3·5	0·0	+0·1	+5·6	..	..	..	..	..	..	..	..
St. Mary's Hospital	−5·1	−4·8	−0·8	+5·9	−3·5	−0·7	−1·8	+0·6	+6·2	+4·5	+4·7	+2·2	+3·5	+3·3	+1·9	−2·0	−2·0	+5·4	−1·8	−0·6	−4·0	−2·9	+2·6	+3·2	+2·1	+3·5
Bethnal Green	..	..	..	..	..	..	..	..	..	..	..	+2·6	+1·8	+3·1	+0·8	−2·7	−2·5	+4·2	−2·3	−1·2	−5·0	−2·4	+1·8	+4·7	..	..
St. John's Wood	−4·3	−3·8	+1·0	+3·3	−4·4	−1·6	−2·2	−0·2	+5·3	+1·2	+3·8	..	..	..	..	..	..	..	..	−2·0	−5·3	−4·3	+0·7	+1·6	+1·0	+1·0
St. Pancras	..	..	..	..	..	..	..	..	..	..	..	+0·2	−1·8	+0·2	−0·9	−3·2	−3·1	+3·2	−0·5	−0·6	..	..	..	..	..	..
Highgate	..	..	..	..	..	..	..	..	..	..	+4·4	+4·0	+5·0	+3·5	+3·0	−0·7	−0·3	+4·5	−0·7	−1·4	−4·5	−2·9	+2·1	+3·3	..	+2·7
Enfield Vicarage	−4·3	−5·8	−0·8	+3·7	−2·3	−4·0	..	−0·1	..	..	−1·6	+2·7	−2·0	+0·2	−0·5	−4·7	−2·8	..	−3·5	−2·8	..	−3·9	+0·1	0·0	−0·6	+0·4
Means	−4·5	−5·0	+1·3	+4·1	−3·2	−1·7	−1·3	+0·7	+6·3	+2·5	+4·1	+2·7	+1·2	+2·1	+1·0	−2·5	−2·2	+3·6	−1·7	−1·0	−4·5	−2·5	+1·5	+3·1	+1·8	+1·6

The numbers in this Table show the weekly departure from the normal temperature of the week at all stations. In analysing them, the first fact worthy of note is that, for the most part, all stations in the same week have been in excess, or all in defect; the next remarkable fact is, that these departures from the averages are not equal in amount. The greatest difference in these respects took place within the first three weeks in September. For instance, the excess of temperature in the first week at St. Thomas's Hospital was 5·2°; at Chiswell Street and Brixton it was 8¾°; the next week the mean temperature at Bexley Heath was that of its average, whilst other stations were in excess from 2° to 5°. In the following week the mean temperature at Enfield was 1½° below its average, whilst at other stations it varied to nearly 6° above; at Brixton it seemed to be as large as 8°, but the instruments at this station had been placed too near the surface of the soil, and some suspicion reigns over the results up to this time. They were subsequently removed to a better position. Similar differences are shown week by week, showing the operation of local causes to affect the temperature of particular districts.

The mean results for the different stations for the thirteen weeks ending November 25, are as follows.—

At Sydenham	was	0·7	in defect.
„ Lewisham	„	0·5	in excess.
„ Royal Observatory	„	0·1	in excess.
„ Bexley Heath	„	0·5	in excess.
„ Brixton	„	2·6	in excess.
„ Camberwell	„	0·4	in excess.
„ Battersea	„	1·0	in defect.
„ Dreadnought Hospital Ship	„	2·2	in excess.
„ Milbank	„	0·3	in excess.
„ Brompton	„	1·0	in defect.
„ Board of Health	„	0·0	
„ St. Thomas's Hospital	„	0·5	in excess.
„ Poplar	„	0·1	in defect.
„ Guildhall	„	0·3	in defect.
„ Somerset House	„	0·8	in excess.
„ St. Giles's	„	0·5	in excess.
„ Chiswell Street	„	4·0	in excess.
„ St. Mary's Hospital	„	1·6	in excess.
„ Bethnal Green	„	0·1	in defect.
„ St. Pancras	„	0·7	in defect.
„ Highgate	„	1·5	in excess.
„ Enfield	„	1·7	in defect.

The numbers in the lowest line of Table VIII. show the mean departure of the temperature of the Metropolitan districts in each week from its average. From them we learn that the temperature was in defect, with the exception of the two weeks ending July 22 and 29, till August 19; then in excess till October 14; in defect in the two following weeks; in excess in the week ending November; in defect till December 2, and afterwards in excess. The most continuous excesses were, therefore, in the seven weeks ending October 14, and the largest excess of temperature took place in the week ending September 2.

It remains now to compare the monthly temperature, as observed throughout the year, with the mean monthly temperature at one of the stations, as deduced from the mean of several years. For this purpose I have used the series of observations taken at the Royal Observatory, Greenwich. The results are contained in the following Table :—

TABLE IX.—MONTHLY TEMPERATURE of the AIR at the Royal Observatory, Greenwich (1841 to 1854).

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°	°	°	°	°	°	°
1841	33·6	35·3	46·2	47·0	56·8	56·4	57·8	60·5	58·1	48·8	42·7	40·5
1842	32·9	40·8	44·9	45·2	53·2	62·9	60·2	65·4	56·4	45·4	42·8	45·0
1843	39·9	36·0	42·9	47·1	52·2	56·3	60·9	62·1	59·5	48·0	43·8	43·9
1844	39·1	35·2	41·5	51·7	52·9	60·7	61·4	57·7	56·9	49·5	44·0	33·0
1845	38·3	32·7	35·2	46·3	49·4	60·7	59·8	57·3	53·6	50·2	45·8	41·7
1846	43·7	43·9	43·3	47·1	54·6	65·3	64·5	63·2	60·1	50·5	46·0	32·9
1847	35·1	35·4	41·0	45·3	56·4	58·0	65·4	62·1	54·3	52·9	46·9	42·8
1848	34·6	43·4	43·8	47·6	59·7	58·5	61·5	58·5	55·8	51·6	43·8	44·0
1849	40·1	43·2	42·5	43·2	51·0	57·9	62·1	62·9	58·8	51·1	44·1	39·1
1850	33·7	44·7	39·9	48·5	51·3	60·8	62·2	60·2	56·4	47·0	46·5	40·6
1851	42·9	40·1	42·6	44·7	50·9	58·9	60·1	62·3	56·9	52·6	37·9	40·4
1852	42·0	40·8	41·3	45·9	51·5	56·1	66·6	62·1	56·8	47·9	48·9	47·6
1853	42·4	33·3	38·5	45·2	52·0	58·2	60·3	60·0	55·3	50·9	42·1	34·0
Means -	38·3	38·8	41·8	46·5	53·4	59·3	61·8	61·1	56·8	49·7	44·3	40·4
1854 -	39·0	39·5	43·8	48·4	50·9	55·7	60·3	60·9	58·1	49·4	40·5	41·3
Excess of Temp. in 1854 -	+ 0·7	+ 0·7	+ 2·0	+ 1·9	− 2·5	− 3·6	− 1·5	− 0·2	+ 1·3	− 0·3	− 3·8	+ 0·9

The lowest line but two gives the mean monthly temperature from 13 years ending 1853. The lowest line but one gives the mean monthly temperature of 1854; and the lowest line of all gives the monthly departure of temperature in 1854 from the mean of the preceding 13 years. From these it appears that the temperature was in excess till April, and in September and December, and in defect in all the remaining months. The summer was cold. The mean yearly temperature for the 13 years ending 1853, was 49·4°, and of 1854 was 49·0°. The investigation of the mean temperature of the several Metropolitan districts, exhibit up to this point very little variation of temperature, as compared each with the other, and we may fairly come to the conclusion that the actual temperature of the air has exercised no very decided influence over the disease, which has been so partial in its operation, devastating entire districts and passing nearly harmlessly by others, which, according to the above results, have shared the same temperature; considering, however, that the amount of daily range of temperature exercises a more active influence on the health of the people than the mean temperature of the air, I have regarded this part of the investigation as highly important to the present inquiry.

The diurnal range of temperature is given by the results derived from self-registering maximum and minimum thermometers. The maximum thermometer employed is that patented by Negretti and Zambra; in this instrument there is no index of steel, which is therefore free from the entanglement and frequent derangements to which the ordinary maximum thermometers are liable. In the series of observations no blanks occur as arising from failure of action, although in several cases it was placed in the hands of gentlemen previously unaccustomed to the use of such instruments. Confidence may be placed in the results, which are given in the following Table:—

TABLE X.—Weekly Means of Daily Maximum Temperature.

Name of Station.	Week ending																									
	July				August				September					October				November				December				
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Sydenham	..	..	..	..	..	..	..	..	..	..	69·4	63·8	63·2	62·4	57·5	51·2	51·0	56·3	47·6	46·5	40·5	..	46·5	48·8	..	42·4
Lewisham	68·7	66·4	77·6	80·2	67·1	71·3	72·7	74·0	78·7	76·3	72·3	67·3	70·2	65·3	60·6	54·0	54·5	59·6	50·0	47·0	42·2	45·2	47·4	49·2	45·3	44·9
Royal Observatory	68·5	67·2	76·9	79·9	68·4	72·5	72·3	74·2	79·8	76·1	73·5	68·4	70·3	65·5	61·2	54·2	55·1	60·2	50·5	47·5	42·7	44·8	47·4	48·9	46·8	45·3
Bexley Heath	..	..	..	..	..	..	..	..	74·2	69·6	66·6	70·4	69·3	67·4	62·8	53·7	54·4	60·3	50·2	49·3	43·2	48·0	49·3	49·0	47·8	46·1
Camberwell	..	..	..	..	..	..	..	..	..	..	71·9	69·2	68·8	66·6	63·3	54·1	55·2	59·7	52·1	..	..	48·8	48·3	48·7	46·9	..
Dreadnought	..	..	..	..	..	..	..	..	..	..	70·9	70·3	67·5	63·5	61·3	..	..	..	..	..	..	..	..	..	..	..
Millbank	..	..	..	..	..	..	..	..	..	..	..	63·6	65·4	62·9	59·0	52·4	52·1	58·1	50·7	47·5	42·0	44·8	48·6	47·6	48·8	45·0
Brompton	..	..	..	..	..	..	..	..	..	..	..	64·5	64·1	61·0	57·8	52·4	50·6	55·0	49·2	46·8	41·7	44·7	46·8	48·0	..	..
Board of Health	..	..	..	..	..	..	..	..	..	..	67·2	66·9	63·3	62·1	59·6	52·3	50·6	56·6	47·7	47·1	41·0	45·5	46·7	47·5	45·3	42·4
St. Thomas' Hosp.	66·8	65·4	76·8	79·8	68·6	67·1	71·7	72·5	74·6	70·5	69·0	66·6	63·1	61·4	..	52·6	52·1	57·7	49·0	46·9	41·8	43·9	48·1	48·0	47·5	47·4
Poplar	..	..	..	..	..	..	..	..	..	..	..	68·0	66·5	63·3	..	..	..	..	..	..	..	..	..	..	..	..
Somerset House	..	..	..	..	..	..	..	..	..	..	70·0	65·2	64·4	64·6	60·0	53·8	53·3	58·1	51·6	50·4	42·2	46·9	49·7	49·2	48·0	..
St. Giles	..	..	..	..	..	..	..	..	..	..	..	67·6	64·6	64·0	60·2	53·5	52·2	58·4	49·9	49·3	..	..	..	..	..	..
Chiswell street	..	..	..	..	..	..	..	..	76·6	73·0	69·4	67·9	65·3	..	60·7	53·9	53·4	59·4	..	..	..	..	..	..	..	..
St. Mary's Hosp.	65·7	66·0	76·0	80·8	67·7	72·3	70·9	72·6	..	76·5	72·4	67·1	71·3	65·2	62·1	54·2	54·6	60·2	50·5	47·1	42·6	45·5	48·2	48·4	47·1	46·4
Bethnal Green	..	..	..	..	..	..	..	..	..	..	..	67·8	68·7	..	59·9	52·3	51·4	58·0	50·5	47·9	41·9	45·6	48·6	48·5	..	..
St. John's Wood	67·6	66·6	76·2	77·5	66·6	71·1	71·1	71·9	77·2	72·3	70·8	..	..	..	..	..	..	..	..	47·1	41·8	45·5	47·3	48·0	46·8	45·5
St. Pancras	..	..	..	..	..	..	..	..	..	..	..	65·6	62·7	63·7	58·3	52·2	51·7	56·3	49·7	47·4	..	..	..	..	..	..
Highgate	..	..	..	..	..	..	..	..	..	..	69·1	71·4	69·6	65·5	62·5	56·9	57·3	60·0	51·1	46·5	41·9	46·0	48·5	47·9	..	46·9
Enfield Vicarage	67·9	65·1	72·3	76·5	67·8	65·5	..	70·1	..	..	67·9	66·9	63·7	63·7	58·9	51·1	50·3	55·1	49·1	45·6	..	43·4	45·1	45·1	44·1	43·1
Means	67·5	66·1	76·0	79·1	67·7	70·0	71·7	72·6	76·8	73·5	70·1	67·3	66·4	63·8	60·3	53·3	53·0	58·2	50·1	47·4	41·9	45·6	47·8	48·2	46·8	45·1
Means as found from— Sydenham, Lewisham, Bexley Heath, Royal Observ., St. John's Wood, St. Pancras, Highgate, Enfield	68·2	63.9	75·7	78·5	67·5	70·1	72·0	72·5	77·5	73·6	69·9	67·7	67·0	64·5	60·3	53·3	53·5	58·3	49·8	46·7	41·8	45·5	47·4	48·1	46·0	44·8

In glancing at the numbers in this Table we perceive that for the most part the temperature at the central stations, has not risen so high during the day as at the outlying stations. The results from Camberwell in this instance, and in all others, show that this station is beyond the influence of the thick atmosphere of London, and that it has enjoyed its full share of high day temperature.

In the last two lines of the Table are given the mean results for all stations, and those derived from the suburban stations only. By comparing the results at the several stations with the numbers in the lower line, it is easy to determine the amount of deficiency of maximum day temperature at the central stations. The results of this comparison are shown in the following Table :—

TABLE XI.—Showing the Defect of London High Day Temperature.

Name of Station.	Week ending																								
	July				August				September					October				November				December				
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Dreadnought	..	..	..	..	..	..	..	..	..	..	+1·0	+2·6	+0·5	−1·0	+1·0	..	..	..	..	..	..	..	..	..	..	..
Millbank	..	..	..	..	..	..	..	..	..	..	..	−4·1	−1·6	−1·6	−1·3	−0·9	−1·4	−0·2	+0·9	+0·8	+0·2	−0·7	+1·2	−0·5	+2·8	+0·8
Brompton	..	..	..	..	..	..	..	..	..	..	..	−3·2	−2·9	−3·5	−2·5	−0·9	−2·9	−3·3	−0·6	+0·1	−0·1	−0·8	−0·6	−0·1	..	..
Board of Health	..	..	..	..	..	..	..	..	..	..	−2·7	−0·8	−3·7	−2·4	−0·7	−1·0	−2·9	−1·7	−2·1	+0·4	−0·8	0·0	−0·7	−0·6	−0·7	−2·4
St. Thomas' Hosp.	−1·4	−0·9	−0·9	+1·3	+1·1	−3·0	−0·3	0·0	−2·9	−3·1	−0·9	−1·1	−3·9	−3·1	..	−0·7	−1·4	−0·6	−0·8	+0·2	0·0	−1·6	+0·7	−0·1	+1·5	+2·6
Poplar	..	..	..	..	..	..	..	..	..	..	..	+0·3	−0·5	−1·2	..	..	..	..	..	..	..	..	..	..	..	..
Somerset House	..	..	..	..	..	..	..	..	..	..	+0·1	−2·5	−2·6	+0·1	−0·3	+0·5	−0·2	−0·2	+1·8	+3·7	+0·4	+1·4	+2·3	+1·1	+2·0	..
St. Giles	..	..	..	..	..	..	..	..	..	..	..	−0·1	−2·4	−0·5	−0·1	+0·2	−1·3	+0·1	+0·1	+2·6	..	..	..	..	..	..
Chiswell Street	..	..	..	..	..	..	..	..	−0·9	−0·6	−0·5	+0·2	−1·7	..	+0·4	+0·6	−0·1	+1·1	..	..	..	..	.	..	..	..
St. Mary's Hosp.	−2·5	−0·3	+0·3	+2·3	+0·2	+2·2	−1·1	+0·1	..	+2·9	+2·5	−0·6	+4·3	+0·7	+1·8	+0·9	+1·1	+1·9	+0·7	+0·4	+0·8	0·0	+0·8	+0·3	+1·1	+1·6
Bethnal Green	..	..	..	..	..	..	..	..	..	..	..	+0·1	+1·7	..	−0·4	−1·0	−2·1	−0·3	+0·7	+1·2	+0·1	+0·1	+1·2	+0·4	..	..
Means	−2·0	−0·6	−0·3	+1·8	+0·6	−0·4	−0·7	0·0	−1·9	−0·3	−0·1	−0·8	−1·2	−1·4	−0·2	−0·3	−1·2	−0·4	+0·1	+1·3	+0·1	−0·2	+0·7	+0·1	+1·3	+0·6

The signs + and − respectively signify above or below the high day temperature of the suburban districts.

From the preponderance of − over + signs, contained in this Table, it appears that the high day temperature of London has generally been below that of the surrounding districts; nor is this remarkable, the sun's rays having first to penetrate the thick atmosphere which generally overhangs all large towns and cities, but more particularly London, and for this reason the duration of high day temperature is shorter than in the country*. The deficiency, as shown in the foregoing Table, is somewhat less than might have been expected, considering the amount of watery vapour and miscellaneous exhalations which require to be dispersed by the sun light and heat of the day, particularly following cloudy and calm nights, when the atmosphere would necessarily be surcharged with vapour.

The next Table contains the results derived from the minimum thermometers.

* During the months of September and October J. Campbell, Esq., of the Board of Health, kindly furnished me with pieces of black ribbon which he had placed daily in the focus of a spherical lens, at the Board of Health, and which, whenever the sun shone, was marked by a burnt line, or on partially clear days by a series of holes. The duration and time of sunshine was thus shown by this ingenious contrivance of Mr. Campbell's, and would have been highly valuable in this investigation had a similar apparatus been simultaneously in action in the suburban districts.

TABLE XII.—Weekly Means of Nightly Minimum Temperature.

Name of Station.	July 8	July 15	July 22	July 29	August 5	August 12	August 19	August 26	September 2	September 9	September 16	September 23	September 30	October 7	October 14	October 21	October 28	November 4	November 11	November 18	November 25	December 2	December 9	December 16	December 23	December 30
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Sydenham	..	..	..	..	..	..	..	..	..	..	53·2	50·3	47·5	48·1	44·0	40·0	38·6	43·1	34·6	35·2	33·1	..	36·1	38·0	..	31·8
Lewisham	51·1	50·1	51·9	53·5	53·8	53·0	49·0	50·7	51·3	45·7	48·2	49·6	42·1	44·5	42·9	41·2	37·0	39·0	34·0	34·3	32·4	32·7	36·2	35·0	33·7	33·9
Royal Observatory	50·8	49·9	52·0	52·1	53·3	52·9	49·9	51·7	53·0	45·2	49·6	49·6	42·8	45·2	43·5	41·7	37·2	41·6	35·9	34·9	32·7	33·7	36·0	37·4	35·6	35·4
Bexley Heath	..	..	..	..	..	..	..	..	51·6	44·7	50·4	51·4	43·7	44·3	44·4	41·3	37·3	41·1	33·5	36·0	31·5	33·5	37·0	35·6	33·2	34·3
Brixton Road	..	..	..	..	..	..	..	..	51·0	46·7	56·5	49·9	41·0	46·0	42·6	40·4	34·3	42·0	34·2	37·7	30·8	..	..	..	..	..
Camberwell	..	..	..	..	..	..	..	..	..	..	50·9	48·6	40·6	43·6	43·9	40·5	36·3	38·5	35·9	..	..	34·8	34·6	36·1	32·2	..
Dreadnought	..	..	..	..	..	..	..	..	..	..	52·6	52·1	44·6	48·2	47·1	44·4	42·1	45·4	39·2	..	..	..	..	..	..	..
Millbank	..	..	..	..	..	..	..	..	..	..	..	52·2	46·6	47·4	45·3	42·2	38·9	43·2	36·0	37·0	35·1	32·6	41·1	37·9	..	34·6
Brompton	..	..	..	..	..	..	..	..	..	..	..	52·9	44·6	49·3	45·4	42·4	37·7	43·1	35·7	37·9	34·6	34·1	37·7	38·9	35·4	..
Board of Health	..	..	..	..	..	..	..	..	..	..	54·4	53·0	46·6	46·7	46·0	42·5	38·8	42·9	37·5	37·8	34·9	34·5	37·7	39·4	35·3	33·2
St. Thomas' Hosp.	53·2	52·3	56·6	58·3	55·1	55·4	54·1	56·3	58·8	52·3	55·2	52·4	44·8	48·5	46·3	42·5	39·9	43·6	37·5	36·7	34·2	34·0	38·3	37·5	34·9	34·0
Poplar	..	..	..	..	..	..	..	..	..	..	55·3	52·7	45·5	46·8	..	..	..	..	..	..	..	..	..	..	..	..
Somerset House	..	..	..	..	..	..	..	..	..	..	..	51·4	46·9	48·0	46·8	41·8	39·8	44·8	37·7	38·0	34·4	34·0	38·9	38·2	33·5	36·1
St. Giles	..	..	..	..	..	..	..	..	..	..	..	53·0	49·7	40·0	48·8	42·8	39·8	45·3	37·3	38·5	..	..	..	..	..	..
Chiswell Street	..	..	..	..	..	..	..	..	62·0	54·6	57·0	53·2	50·4	..	49·3	44·7	41·0	47·6	..	..	..	..	..	..	..	..
St. Mary's Hosp.	53·5	52·1	54·5	57·4	54·7	55·0	51·9	52·9	..	51·1	53·4	53·0	46·3	46·7	44·9	41·9	39·1	44·3	35·6	37·7	35·2	33·1	39·0	37·9	34·8	35·5
Bethnal Green	..	..	..	..	..	..	..	..	..	..	..	53·2	43·7	..	44·9	41·0	37·2	42·2	34·8	35·5	33·1	33·9	37·2	38·8	..	..
St. John's Wood	49·8	40·5	50·8	54·0	52·8	51·8	47·8	49·6	53·8	47·9	49·4	..	..	..	..	..	..	..	..	34·9	32·5	29·7	35·6	35·2	31·7	31·4
St. Pancras	..	..	..	..	..	..	..	..	..	..	..	44·1	39·9	39·9	38·3	39·3	42·0	43·7	39·1	37·4	..	..	..	..	..	..
Highgate	..	..	..	..	..	..	..	..	..	..	51·9	49·5	46·6	48·6	45·0	40·0	37·7	41·5	34·2	35·2	32·3	30·4	35·5	35·2	..	32·0
Enfield Vicarage	50·9	49·8	51·1	54·7	54·6	51·2	..	52·6	..	..	45·1	50·6	41·2	43·9	42·6	37·3	..	36·6	32·9	33·8	..	29·6	35·9	34·0	31·6	31·4
Means	51·5	50·6	52·8	55·0	54·0	53·2	50·5	52·3	54·5	48·5	51·9	50·7	44·9	46·4	44·8	41·5	38·6	42·6	36·2	36·5	33·6	32·2	37·1	37·0	33·8	33·6
Means as found from— Sydenham, Lewisham, Royal Observ., Bexley Heath, St. John's Wood, St. Pancras, Highgate, Enfield	50·6	49·8	51·5	53·6	53·6	52·2	48·9	51·1	52·4	45·9	49·7	49·3	43·4	44·9	43·0	40·1	38·1	40·9	35·6	35·1	32·7	32·0	36·1	35·9	33·5	33·1

An inspection of the numbers in this Table shows that at the central stations the night temperatures have been much higher than at the boundary stations. The numbers in the lower line but one, show the mean lowest temperatures of night over the Metropolitan districts, and those in the lowest line of all, the mean night temperature of the stations beyond the influence of London. By comparing the numbers at the central stations with those in the lowest line, the excess of the night temperature of London at the various stations will be found. The results of this comparison are shown in the next Table.

TABLE XIII.—Showing the Excess of London Low Night Temperature.

Name of Station.	Week ending: July 8	15	22	29	August 5	12	19	26	September 2	9	16	23	30	October 7	14	21	28	November 4	11	18	25	December 2	9	16	23	30
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Dreadnought	..	..	..	..	..	..	..	..	..	..	+2·9	+2·8	+1·2	+3·3	+4·1	+4·3	+4·0	+4·5	+3·6	..	..	..	..	..	..	..
Millbank	..	..	..	..	..	..	..	..	..	..	..	+2·9	+3·2	+2·5	+2·3	+2·1	+0·8	+2·3	+0·4	+1·9	+2·4	+0·6	+5·0	+2·0	..	+1·5
Brompton	..	..	..	..	..	..	..	..	..	..	..	+3·6	+1·2	+4·4	+2·4	+2·3	−0·4	+2·2	+0·1	+2·8	+1·9	+2·1	+1·6	+3·0	+1·9	..
Board of Health	..	..	..	..	..	..	..	..	..	..	+4·7	+3·7	+3·2	+1·8	+3·0	+2·4	+0·7	+2·0	+1·9	+2·7	+2·2	+2·5	+1·6	+3·5	+1·8	+0·1
St. Thomas' Hosp.	+2·6	+2·5	+5·1	+4·7	+1·5	+3·2	+5·2	+5·2	+6·4	+6·4	+5·5	+3·1	+1·4	+3·6	+3·3	+2·4	+1·8	+2·7	+1·9	+1·6	+1·5	+2·0	+2·2	+1·6	+1·4	+0·9
Poplar	..	..	..	..	..	..	..	..	..	..	+5·6	+3·4	+2·1	+1·9	..	..	..	..	..	..	..	..	..	..	..	..
Somerset House	..	..	..	..	..	..	..	..	..	..	..	+3·1	+3·5	+3·1	+3·8	+1·7	+1·7	+3·9	+2·1	+2·9	+1·7	+2·0	+2·8	+2·3	0·0	+3·0
St. Giles	..	..	..	..	..	..	..	..	..	..	..	+3·7	+6·3	+4·1	+5·8	+2·7	+1·7	+4·4	+1·7	+3·4	..	..	..	..	..	..
Chiswell Street	..	..	..	..	..	..	..	..	+9·6	+8·7	+7·3	+3·9	+7·0	..	+6·3	+4·6	+2·9	+6·7	..	..	..	..	..	..	..	..
St. Mary's Hosp.	+2·9	+2·3	+3·0	+3·8	+1·1	+2·8	+3·0	+1·8	..	+5·2	+3·7	+3·7	+2·9	+1·8	+1·9	+1·8	+1·0	+3·4	0·0	+2·6	+2·5	+1·1	+2·9	+2·0	+1·3	+2·4
Bethnal Green	..	..	..	..	..	..	..	..	..	..	..	+3·9	+0·3	..	+1·9	+0·9	−0·9	+0·3	−0·8	+0·4	+0·4	+1·9	+1·1	+2·9	..	..
Means	+2·7	+2·4	+4·0	+4·2	+1·3	+3·0	+4·1	+3·5	+8·0	+6·8	+4·3	+3·4	+2·9	+2·9	+3·5	+2·5	+1·3	+3·2	+1·2	+2·2	+1·6	+1·7	+2·5	+2·5	+1·5	+1·6

From the numbers in this Table it will be seen that London night temperature has been high in every week, that it exceeded that of the suburban districts in September, by quantities ranging from 3° to 8°. The mean excess in each week is shown in the lower line. The mean for the 26 weeks ending December 30, is 3°, showing the average excess of minimum night temperature in London over that of the country.

I have thus determined by actual observation and comparison the excess of night temperature of London over the country and surrounding districts. An equally full determination of the diurnal range of temperature is required. The amount of range was determined daily, and the mean of each week was taken and checked by taking the difference between the numbers in Table X. and in Table XII. The results are contained in the following Table :—

TABLE XIV.—WEEKLY MEANS of DAILY RANGE of TEMPERATURE.

NAME OF STATION.	WEEK ENDING July 8	July 15	July 22	July 29	August 5	August 12	August 19	August 26	September 2	September 9	September 16	September 23	September 30	October 7	October 14	October 21	October 28	November 4	November 11	November 18	November 25	December 2	December 9	December 16	December 23	December 30
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Sydenham	..	..	..	..	..	..	..	..	..	..	16·2	13·5	15·7	14·3	13·5	11·2	12·4	13·2	13·0	11·3	7·4	..	10·4	10·8	..	10·6
Lewisham	17·6	16·3	25·7	26·7	13·3	18·3	23·7	23·3	27·4	30·6	25·0	17·7	28·1	20·8	17·7	12·8	17·5	20·6	16·0	12·7	9·8	12·5	11·2	14·2	11·6	11·0
Bexley Heath	..	..	..	..	..	..	..	..	22·6	24·9	16·2	19·0	27·6	23·1	18·4	12·4	17·1	19·2	16·7	13·3	11·7	14·5	12·3	13·4	14·6	11·8
Camberwell	..	..	..	..	..	..	..	..	..	..	21·0	20·6	28·2	23·0	19·4	13·6	18·9	21·2	16·2	..	..	14·0	13·7	12·6	14·7	—
Dreadnought	..	..	..	..	..	..	..	..	..	..	18·3	18·2	22·9	15·3	14·2	—	—	—	—	—	—	—	—	—	—	—
Millbank	..	..	..	..	..	..	..	.	..	.	..	11·4	18·8	15·5	13·7	10·2	13·2	14·9	14·7	10·5	6·9	12·2	7·5	9·7	..	11·0
Brompton	..	..	..	..	..	..	..	..	..	..	..	11·6	19·5	11·7	12·4	10·0	12·9	11·9	13·5	10·9	7·1	10·6	9·1	9·1	—	—
Board of Health	..	..	..	..	..	..	..	..	..	..	12·8	13·9	16·7	15·4	13·6	10·0	12·1	13·7	10·2	9·3	6·1	11·0	9·0	8·1	10·0	8·2
St. Thomas's Hosp.	13·6	13·1	20·2	21·5	13·5	11·7	17·6	16·2	23·8	18·2	13·8	14·2	18·3	12·9	..	10·1	12·2	14·1	11·5	10·2	7·6	9·9	9·8	10·5	12·6	13·4
Poplar	..	..	..	..	..	..	..	..	..	..	..	15·3	21·0	16·5	—	—	—	—	—	—	—	—	—	—	—	—
Somerset House	..	..	..	..	..	..	..	..	..	..	..	13·8	17·5	16·6	13·2	12·0	13·5	13·3	13·9	12·4	7·8	12·9	10·8	11·0	14·5	—
St. Giles	..	..	..	..	..	..	..	..	..	..	..	14·6	14·9	15·0	11·4	10·7	12·4	13·1	12·6	10·8	—	—	—	—	—	—
Chiswell Street	..	..	..	..	..	..	..	..	14·6	18·4	12·4	14·7	14·9	..	11·4	9·2	11·6	11·8	—	—	—	—	—	—	—	—
St. Mary's Hosp.	12·2	13·9	21·5	23·4	13·0	17·3	19·0	19·7	..	25·4	19·0	14·1	25·0	18·5	17·2	12·3	15·5	15·9	14·9	9·4	7·4	12·4	9·2	10·5	12·3	10·9
Bethnal Green	..	..	..	..	..	..	..	..	..	..	..	14·6	25·0	..	15·0	12·2	14·2	15·8	15·7	12·4	8·8	11·6	11·4	9·7	—	—
St. John's Wood	17·8	17·1	25·4	23·5	13·8	19·3	23·3	22·3	23·4	24·4	21·4	..	..	..	..	..	..	..	..	12·2	9·3	15·8	11·7	12·8	15·1	14·1
St. Pancras	..	..	..	..	..	..	..	..	..	..	..	21·5	22·8	23·8	20·0	12·7	9·7	12·6	10·6	10·0	—	—	—	—	—	—
Highgate	..	..	..	..	..	..	..	..	..	..	17·2	21·9	23·0	16·9	17·5	16·9	19·6	18·5	16·7	11·3	9·6	15·6	13·0	12·7	..	14·9
Royal Observatory	17·7	17·3	24·9	27·8	15·1	19·6	22·4	22·5	26·8	30·9	23·9	18·8	27·5	18·3	17·7	12·5	17·9	18·6	14·6	12·6	10·0	11·1	11·4	11·5	11·2	9·9
Enfield Vicarage	17·0	15·3	21·2	21·8	13·2	14·3	..	17·5	..	..	22·8	16·3	22·5	19·8	16·3	13·8	..	18·5	16·2	11·8	..	13·8	9·2	11·1	12·5	12·7
Means	16·0	15·5	23·1	24·1	13·7	16·8	21·0	20·2	23·1	24·7	18·4	16·1	21·6	19·4	15·4	11·9	14·4	15·7	13·9	11·4	8·3	12·7	10·6	11·2	12·9	11·7
Means as found from:— Sydenham, Lewisham, Royal Observ., Bexley Heath, St. John's Wood, St. Pancras, Highgate, Enfield	17·6	16·5	24·2	24·9	13·9	17·9	23·1	21·4	25·1	27·7	20·2	18·4	23·6	19·6	17·3	13·2	15·4	17·2	14·2	11·6	9·1	13·5	11·2	12·3	12·5	11·8

The results contained in this Table possess great interest in connexion with the climate of London; we learn from them, that in every week the range of temperature within twenty-four hours, has been from 2° to 10° less than the range in the country. Till September 2, the stations are all outlying, but in this week the results from Chiswell Street are included, and exhibit a range the half only of the other stations; in the weeks from September 9, the results are from a greater number of stations, and the same general fact of much smaller range at the central stations are shown week by week. To determine its amount, the difference between the individual numbers and those in the last line of the Table are shown as follows:—

TABLE XV.—Showing the Less Daily Range of Temperature in London.

Name of Station.	Week Ending																										
	July				August				September					October				November				December				
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Dreadnought	..	..	..	..	..	..	..	..	..	..	−1·9	−0·2	−0·7	−4·3	−3·1	..	..	..	..	..	..	..	..	..	..	..
Millbank	..	..	..	..	..	..	..	..	..	..	..	−7·0	−4·8	−4·1	3·6	−3·0	−2·2	−2·2	+0·5	−1·1	−2·2	−1·3	−3·7	−2·6	..	−0·8
Brompton	..	..	..	..	..	..	..	..	..	..	..	−6·8	−4·1	−7·9	−4·9	−3·2	−2·5	−5·2	−0·7	−0·7	−2·0	−2·9	−2·1	−3·2	..	..
Board of Health	..	..	..	..	..	..	..	..	..	..	−7·4	−4·5	−6·9	−4·2	−3·7	−3·2	−3·3	−3·4	−4·0	−2·3	−3·0	−2·5	−2·2	−4·2	−2·5	−3·6
St. Thomas' Hosp.	−4·0	−3·4	−4·0	−3·4	−0·4	−6·2	−5·5	−5·2	− 1·3	−9·5	−6·4	−4·2	−5·3	−6·7	..	−3·1	−3·2	−3·0	−2·7	−1·4	−1·5	−3·6	−1·4	−1·8	+0·1	+1·6
Poplar	..	..	..	..	..	..	..	..	..	..	..	−3·1	−2·6	−3·1	..	..	..	..	..	..	..	..	..	..	..	..
Somerset House	..	..	..	..	..	..	..	..	..	..	..	−4·6	−6·1	−3·0	−4·1	−1·2	−1·9	−3·8	−0·3	+0·8	−1·3	−0·6	−0·4	−1·3	+2·0	..
St. Giles	..	..	..	..	..	..	..	..	..	..	..	−3·8	−8·7	−4·6	−5·9	−2·5	−3·0	−4·0	−1·6	−0·8	..	..	..	..	..	..
Chiswell Street	..	..	..	..	..	..	..	..	−10·5	−9·3	−7·8	−3·7	−8·7	..	−5·9	−4·0	−3·8	−5·3	..	..	..	..	..	..	..	..
St. Mary's Hosp.	−5·4	−2·6	−2·7	−1·5	−0·9	−0·6	−4·1	−1·7	..	−2·3	−1·2	−4·3	+1·4	−1·1	−0·1	−0·9	+0·1	−1·2	+0·7	−2·2	−1·7	−1·1	−2·0	−1·8	−0·2	−0·9
Bethnal Green	..	..	..	..	..	..	..	..	..	..	..	−3·8	+1·4	..	−2·3	−1·0	−1·3	−1·3	+1·5	+0·8	−0·3	−1·9	+0·2	−2·6	..	..
Means	−4·7	−3·0	−3·4	−2·5	−0·7	−3·4	−4·8	−3·5	− 5·9	−7·0	−5·0	−4·2	−4·1	−4·3	−4·5	−2·4	−2·3	−3·3	−0·8	−0·7	−1·7	−2·0	−1·7	−2·5	−0·2	−0·9

The prevalence of − over + signs in this Table establishes the fact of less daily range of temperature in London than in the country, and the numbers show that this deficiency is at times very great. The largest numbers appear in the several weeks in September. The numbers in the lower line show the mean less daily range of temperature in each week in London. The mean for the twenty-six ending December 30, is 3·1°.

It would be interesting to compare daily the minima readings and daily ranges of temperature at the river side and central stations with those at the boundary stations; but to exhibit such here in detail, would occupy more space than can be devoted to the investigation.

In a special inquiry, however, of this nature, it is necessary to enter somewhat more fully into results which exhibit large local irregularities, in preference to those in which small differences alone are found to exist.

In looking over Tables X. and XII., it will be seen that the results from St. Thomas's Hospital are in close agreement with those at the central stations, and this station has the advantage of continuous results. Confining ourselves, therefore, to this as the representative of the central stations, and of Lewisham as the representative of the boundary stations, we have the results shown on the following Table:—

TABLE XVI.—SHOWING the LOWEST TEMPERATURE of the AIR for every Day from JULY to DEC. 31, and the DAILY RANGES of TEMPERATURE at LEWISHAM and ST. THOMAS'S HOSPITAL for the same Period.

1854. — Month and Date.	Temperature of the Air. Lowest at Night. Lewisham.	Temperature of the Air. Lowest at Night. St. Thomas's Hospital.	Excess at St. Thomas's Hospital.	Range of Temperature in the Day. Lewisham.	Range of Temperature in the Day. St. Thomas's Hospital.	Excess at St. Thomas's Hospital.	General Remarks. Boundary Stations.	General Remarks. Central Stations.
July 1	51·5°	53·0°	+ 1·5°	11·5°	9·2°	− 2·3°	Overcast all day; frequent rain - - - - -	Misty; rain overcast.
2	50·0	52·5	+ 2·5	19·6	11·0	− 8·6	Sky almost covered with cloud - - - - -	Overcast; light showers.
3	54·5	55·7	+ 1·2	17·4	10·8	− 6·6	Rain in morning; sky cloudy - - - - -	Misty showers of rain: partially overcast.
4	56·0	57·6	+ 1·6	16·2	14·9	− 1·3	Sky cloudy in morning: rain in afternoon - - -	Sky overcast; showers of rain in afternoon.
5	49·8	51·9	+ 2·1	18·1	17·4	− 0·7	Partially cloudy in morning: showers in afternoon - -	Partially overcast; showers.
6	50·3	52·4	+ 2·1	15·6	15·9	+ 0·3	Sky cloudy all day; occasional rain - - - -	Overcast; occasional rain.
7	41·9	50·2	+ 5·3	21·2	15·9	− 5·3	Morning overcast: afternoon partially cloudy; rain - -	Overcast in morning; light rain.
8	51·9	51·9	0·0	15·6	9·7	− 5·9	Sky nearly covered with cloud; showers in morning - -	Thick rain in morning; afternoon overcast.
9	47·8	51·8	+ 4·0	19·2	17·7	− 1·5	Overcast: lightning, thunder, and showers in afternoon -	Morning slightly overcast; rain in afternoon.
10	48·9	54·2	+ 5·3	21·0	16·1	− 4·9	Overcast all day; rain frequently - - - -	Clear sky in morning; showers.
11	50·5	49·8	− 0·7	15·6	13·9	− 1·7	Morning overcast; afternoon cloudy and hazy - - -	Misty in morning; afternoon overcast.
12	50·4	51·8	+ 1·4	6·8	3·1	− 3·7	Overcast all day; occasional rain - - - -	Morning overcast. heavy rain.
13	48·7	50·8	+ 2·1	19·1	9·7	− 9·4	Morning overcast; afternoon partially cloudy - - -	Overcast all the day.
14	50·0	52·5	+ 2·5	15·2	13·7	− 1·5	Overcast all day; frequent mizzling rain - - - -	Misty rain all day.
15	51·3	55·4	+ 1·1	17·2	8·3	− 8·9	Morning overcast: afternoon fine; showers - - -	Morning partially overcast; heavy rain.
16	51·0	54·3	+ 3·3	25·0	18·2	− 6·8	A fine day; sky tolerably clear - - - - -	Partially overcast.
17	54·2	56·0	+ 1·8	17·2	14·1	− 3·1	Overcast till noon; light clouds in afternoon - - -	Morning overcast; light rain in afternoon.
18	53·1	56·1	+ 3·0	21·8	20·9	− 0·9	A fine day; sky free from cloud - - - - -	Sky clear all day.
19	50·9	55·2	+ 4·3	26·1	23·1	− 3·0	Cloudy, but fine day; evening cloudless - - - -	Partially overcast.
20	52·0	57·4	+ 5·4	25·8	18·8	− 7·0	Fine day; sky partially covered - - - - -	Morning clear, afterwards sky overcast.
21	50·4	57·3	+ 6·9	31·2	15·5	−15·7	Thick haze in morning, fine, sky clear - - - -	Clear sky all day.
22	51·9	59·6	+ 7·7	32·4	25·9	− 6·5	Very fine day; cloudless - - - - - -	Clear sky all day.
23	51·0	61·4	+10·4	38·0	25·6	−12·4	The sky was clear throughout the day - - - -	Sky free from cloud.
24	54·3	61·8	+ 7·5	29·7	23·9	− 5·8	Morning clear; afternoon partially cloudy - - -	Sky clear all the day.
25	58·9	63·6	+ 4·7	29·9	23·3	− 6·6	A fine day; clear sky - - - - - -	Clear sky in morning; afternoon hazy.
26	58·2	60·3	+ 2·1	17·5	16·9	− 0·6	Sky clear till noon; cloudy in afternoon - - - -	Morning overcast; hazy; heavy rain.
27	55·9	56·2	+ 0·3	16·6	8·6	− 8·0	Overcast all day, rain at night - - - - -	Overcast all day; rain at night.
28	52·5	54·0	+ 1·5	21·0	12·9	− 8·1	Sky partially cloudy; night clear - - - - -	Partially overcast all day.
29	43·4	50·9	+ 7·5	34·4	19·1	−15·3	Hazy; cloudy; evening clear - - - - -	Sky nearly overcast; rain.
30	56·3	58·0	+ 1·7	25·3	13·3	−12·0	Fine; sky partially cloudy - - - - -	Overcast; thunderstorm in afternoon.
31	58·0	60·8	+ 2·8	18·1	15·9	− 2·2	Morning overcast; afternoon partially clear - - -	Showers; overcast in morning; afternoon rain.
Means -	52·0	55·3	+ 3·3	21·2	15·6	− 5·6		

August	1	58·1	55·4	− 2·7	11·3	17·8	+ 6·5	Morning overcast; afternoon partially cloudy; rain	Morning partially overcast; rain.
	2	49·2	53·4	+ 4·2	21·3	17·9	− 3·4	Morning fine; afternoon overcast; rain	Slightly overcast; rain.
	3	54·5	55·1	+ 0·6	4·5	8·1	+ 3·6	Overcast all day; occasional rain	Rain; thunder.
	4	49·3	50·8	+ 1·5	5·7	8·0	+ 2·3	Overcast; drizzling rain generally	Continued rain all day and during night.
	5	51·5	51·9	+ 0·4	6·5	4·0	− 2·5	Overcast all day; rain	Overcast all day.
	6	51·2	51·6	+ 0·4	17·2	5·9	−11·3	Morning overcast; afternoon fine and clear	Morning overcast; afternoon partially cloudy.
	7	54·5	53·9	− 0·6	12·1	10·2	− 1·9	Fine; sky overcast till evening	Sky overcast all day.
	8	49·2	53·1	+ 3·9	23·5	12·1	−11·4	A fine day; sky partially cloudy	Fine; sky partially overcast.
	9	51·4	55·9	+ 4·5	18·6	13·0	− 5·6	Alternately overcast and clear; fine day	Partially cloudy; light showers.
	10	55·0	57·8	+ 2·8	20·5	12·1	− 8·4	Overcast till noon; clear afterwards; fine	Sky partially overcast all day.
	11	52·5	55·8	+ 3·3	23·1	15·7	− 7·4	Morning cloudless; partially cloudy afterwards	Sky clear in morning; afternoon partially cloudy.
	12	57·3	59·8	+ 2·5	12·9	12·5	− 0·4	Overcast till afternoon; clear after; fine day	Partially cloudy all day.
	13	51·5	55·5	+ 5·0	29·0	15·7	−13·3	Fine day; sky partially cloudy	Morning foggy; sky tolerably clear.
	14	56·7	62·2	+ 5·5	20·4	15·9	− 4·5	Cloudy all day; evening clear; fine	Sky partially overcast.
	15	50·4	55·0	+ 4·6	19·4	13·3	− 6·1	Partially cloudy till noon; rain	Morning clear; afterwards overcast and stormy.
	16	48·0	52·9	+ 4·9	21·0	17·3	− 3·7	Overcast till afternoon; misty	Clear sky; afterwards cloudy.
	17	45·0	50·0	+ 5·0	20·2	17·6	− 2·6	Morning fine but hazy; occasional rain	Sky partially overcast; showers.
	18	43·2	48·6	+ 5·4	25·8	15·6	−10·2	Morning overcast; afterwards clear and fine	Sky partially overcast all day.
	19	48·2	53·8	+ 5·6	29·9	17·7	−12·2	Sky partially covered with cloud	Fine day; light clouds.
	20	56·0	58·8	+ 2·8	22·5	16·7	− 5·8	Light rain during morning; evening clear	Morning overcast and showery; afterwards cloudy.
	21	53·9	56·9	+ 3·0	22·1	17·9	− 4·2	Dull day; sky partially covered	Overcast all day; light showers.
	22	50·0	53·5	+ 3·5	22·5	16·0	− 6·5	Few clouds till evening, when clear	Morning partially overcast.
	23	47·0	52·0	+ 5·0	25·0	19·8	− 5·2	Morning clear; a moderately fine day	Overcast all day; rain in evening.
	24	54·0	56·8	+ 2·8	18·5	14·5	− 4·0	Sky partially covered; clear night	Morning nearly clear sky; afterwards partially overcast.
	25	51·0	54·4	+ 3·4	20·0	19·9	− 0·1	Sky partially cloudy; evening clear; misty	Fine; nearly cloudless all day.
	26	43·0	51·4	+ 8·4	32·5	18·9	−13·6	Misty atmosphere; sky tolerably clear	Sky partially overcast all day.
	27	52·0	59·9	+ 7·9	24·0	11·1	−12·9	Mist till 10h; cloudy but fine all day	Partially overcast.
	28	60·5	65·8	+ 5·3	22·5	8·2	−14·3	Cloudy; a fine day	Fair day; lightning during night.
	29	51·0	56·4	+ 5·4	31·8	21·1	−10·7	A very fine day; cloudless	Few clouds; thick hazy fog in evening.
	30	51·5	60·4	+ 8·9	31·7	15·9	−15·8	Cloudless; a very fine day	Very fine day.
	31	53·5	62·1	+ 8·6	20·5	18·3	− 2·2	Cloudy but fine; hazy	Overcast; hazy.
Means	-	51·7	55·5	+ 3·8	20·5	14·5	− 6·0		
Sept.	1	44·2	50·7	+ 6·5	29·0	22·2	− 6·8	Fine day; almost cloudless; hazy	Fine day; hazy.
	2	44·5	51·0	+ 6·5	32·3	19·0	−13·3	Fine day; few clouds; hazy	Fine; hazy; fog in the distance.
	3	43·3	52·0	+ 8·7	36·7	18·1	−18·6	Fog in morning; day very fine	Fog in morning; a fine day, but hazy.
	4	45·1	51·5	+ 6·4	37·1	21·5	−15·6	Thick fog in morning; very fine day	Fog in morning; hazy horizon during the day.
	5	44·9	50·5	+ 5·6	26·3	23·7	− 2·6	Fog in morning; a few clouds; clear at night	Sky generally overcast; thick atmosphere.
	6	41·2	51·2	+ 7·0	32·4	19·0	−13·4	Very fine day; cloudless sky	Morning overcast, but fine in afternoon.
	7	44·1	53·3	+ 9·2	35·0	17·1	−17·9	A few clouds; fine day; hazy	Fog in morning; afternoon overcast; hazy.
	8	48·3	51·6	+ 3·3	22·4	20·4	− 2·0	Fine day; partially cloudy sky; horizon visible 12 to 14 miles.	Clear atmosphere; a fine day.
	9	49·8	52·9	+ 3·1	24·2	11·0	−13·2	A fine day; sky tolerably clear; haze; horizon invisible	Fog; light rain; partially overcast.
	10	40·5	49·3	+ 8·8	29·7	15·2	−14·5	Cloudy sky; hazy all day; horizon hazy	Sky cloudy; fair and fine.
	11	40·1	47·9	+ 7·8	33·8	15·9	−17·9	Fog till noon; sky clear; haze	Morning foggy; fine day; sky cloudless.
	12	37·9	47·0	+ 9·1	43·7	24·5	−19·2	Morning foggy; atmosphere hazy; few clouds; objects invisible half a mile off.	Fog; sky cloudless.
	13	52·8	61·8	+ 9·0	19·1	14·1	− 5·0	Overcast all day; light rain occasionally; haze on ground half a mile distant.	Overcast; hazy; rain.
	14	54·0	59·9	+ 5·9	18.9	10·0	− 8·9	Overcast and hazy; rain; objects visible 3 or 4 miles distant	Overcast; thick and hazy; showers.
	15	53·3	54·3	+ 1·0	18.3	13·9	− 4·4	Overcast all day; atmosphere oppressive; rain; hazy beyond a mile distant.	Cloudy; air oppressive; showers.

TABLE XVI.—Showing the Lowest Temperature of the Air for every Day from July 1 to December 31, &c.—*cont.*

1854. — Month and Day.	Temperature of the Air. Lowest at Night. Lewisham.	Temperature of the Air. Lowest at Night. St. Thomas's Hospital.	Excess at St. Thomas's Hospital.	Range of Temperature in in the Day. Lewisham.	Range of Temperature in in the Day. St. Thomas's Hospital.	Excess at St. Thomas's Hospital.	General Remarks. Boundary Stations.	General Remarks. Central Stations.
Sept. 16	59°·1	61°·0	+ 1°·9	13°·0	9°·1	− 3°·9	Partially cloudy; thin rain at intervals; horizon invisible a mile off.	Overcast; mizzling rain at intervals.
17	53·0	56·2	+ 3·2	21·0	15·3	− 5·7	Cloudy, with partial sunshine	Partially overcast all day.
18	50·6	53·2	+ 2·6	18·0	17·7	− 0·3	Cloudy sky; hazy	Morning fine; afternoon overcast; showers.
19	58·5	57·4	− 1·1	12·5	10·1	− 2·4	Slight sunshine; cloudy, but fine; fog; objects invisible beyond a mile.	Morning overcast; afternoon cloudy; rain.
20	50·0	52·3	+ 2·3	21·0	15·9	− 5·1	Overcast, with occasional sunshine; rain	Overcast; rain.
21	46·0	48·2	+ 2·2	17·4	16·1	− 1·3	Sunshine; sky cloudy; fine; slight haze on landscape visible at 5 or 6 miles distant.	Cloudless, afterwards overcast; showers.
22	40·6	45·1	+ 4·5	29·6	16·5	− 4·1	Sky clear; slight haze; evening clear	Morning cloudless and hazy; showers.
23	48·7	49·6	+ 0·9	13·4	9·4	− 4·0	Overcast all day; haze prevalent	Overcast all day; showers.
24	51·0	53·2	− 0·8	15·5	10·3	− 5·2	A few clouds; hazy in distance; showers	Sky generally clear; fair day.
25	41·8	46·4	+ 3·6	20·4	20·6	+ 0·2	Sunshine; almost cloudless; distance hazy	Haze in morning; sky tolerably clear.
26	39·6	46·4	+ 6·8	28·6	10·4	−18·2	Sunshine; few clouds; haze prevalent	Thick fog in morning and afternoon; cloudless.
27	40·0	46·7	+ 6·7	32·6	15·5	−17·1	Fog till 10; cloudless all day; haze over distance	Fog prevalent; cloudless all day.
28	41·4	48·6	+ 7·2	31·6	17·4	−14·2	Thin fog in morning; cloudless; haze prevalent	Fog in morning; cloudless.
29	37·2	45·7	+ 8·5	35·2	19·9	−15·3	Cloudless; haze prevalent all day	Cloudless; fog and haze prevalent.
30	39·8	46·5	+ 6·7	32·4	14·1	−18·3	Foggy; sky cloudless; distance hazy	Fog and haze prevalent; cloudless.
Means -	46·3	51·5	+ 5·2	25·6	16·0	− 9·6		
October 1	40·2	49·0	+ 8·8	27·0	13·8	−13·2	Dense white fog, afternoon clear; haze	Foggy; afternoon clear.
2	39·0	45·0	+ 6·0	33·2	13·5	−19·7	Fog prevalent, evening clear; haze	Fog in morning; afternoon cloudless.
3	41·9	48·1	+ 3·2	20·2	12·7	− 7·5	Sunshine; cloudless; white haze	Cloudy morning; afternoon partially cloudy.
4	38·6	45·0	+ 6·4	24·4	15·8	− 8·6	Partially cloudy day; misty	Cloudy day, but fine.
5	49·4	52·7	+ 3·3	21·0	11·3	− 9·7	Sunshine; a fine day; sky cloudy	Fair day; afternoon cloudy.
6	51·9	53·0	+ 1·1	7·1	4·5	− 2·6	Haze; drizzling rain all day	Overcast and rain.
7	46·7	46·5	− 0·2	13·2	11·0	− 2·2	Sky covered with cloud	Fair; partially overcast.
8	47·5	47·5	0·0	15·3	9·4	− 5·9	Sunshine; fine day; sky overcast during evening	Fine day; sky clear.
9	52·1	52·1	0·0	16·9	5·9	−11·0	Overcast all day; hazy	Partially overcast; haze prevalent.
10	47·8	50·4	+ 2·6	17·3	10·8	− 6·5	Cloudy, with partial sunshine; hazy	Foggy; light clouds.
11	52·1	50·5	− 1·6	8·4	8·5	+ 0·1	Sunshine; sky nearly cloudless	Fair; clear sky in afternoon.
12	36·5	43·0	+ 6·5	23·5	16·4	− 7·1	Sky cloudless all day	Clear sky; slight haze; foggy.
13	32·7	37·0	+ 4·3	19·8	17·9	− 1·9	Morning foggy and overcast; evening clear	Foggy; sky nearly clear; hazy.
14	37·6	43·4	+ 5·8	16·4	8·6	− 7·8	Overcast all day; fog in evening	Thick haze prevalent; fog.
15	48·5	48·5	0·0	5·2	5·5	+ 0·3	Sky overcast; dull and misty	Fog; sky overcast; showers.

16	43·5	43·0	− 0·5	10·5	10·2	− 0·3	Morning clear; afternoon light clouds	Partially overcast; haze.
17	33·1	38·5	+ 5·4	21·1	14·0	− 7·1	Overcast and damp all day	Overcast all day; showers.
18	43·8	43·2	− 0·6	8·4	8·2	− 0·2	Overcast all day; foggy	Cloudy; slight rain; thick haze.
19	36·7	37·9	+ 1·2	14·8	13·1	− 1·7	A fine day; sunshine; nearly cloudless	Fair; sky partially cloudy.
20	40·6	43·3	+ 2·7	16·3	9·8	− 6·5	Day clear; thin haze; few clouds	Partially overcast; sunshine; showers.
21	43·3	43·2	− 0·1	13·0	9·8	− 3·2	A fine day; few clouds	Fine day; cloudy; slight haze.
22	47·3	47·0	− 0·3	11·8	7·5	− 4·3	Sunshine; a bright day; partially cloudy	Cloudy all day; showers.
23	37·0	42·9	+ 5·9	20·1	12·9	− 7·2	Sunshine till noon; hail and rain in afternoon	Overcast; rain; haze.
24	36·0	37·4	+ 1·4	19·0	15·7	− 3·3	Morning fine and clear; haze and rain afterwards	Morning clear; rain and slight haze.
25	39·6	40·9	+ 1·3	8·2	10·0	+ 1·8	Overcast all day; haze and rain	Morning foggy; rain in afternoon.
26	34·7	36·3	+ 1·6	19·4	11·1	− 8·3	Sunshine; rain in afternoon; hazy	Morning clear; showers in afternoon.
27	29·7	34·0	+ 4·3	28·0	14·5	−13·5	Very fine day; sky bright and clear	Morning foggy; afternoon clear; thick haze.
28	34·4	41·0	+ 6·6	18·1	13·5	− 4.6	Sunshine; few clouds; white haze	Light clouds in morning; overcast afterwards.
29	34·5	39·5	+ 5·0	24·6	14·5	−10·1	A fine day; few clouds in evening	Morning clear; few clouds in afternoon.
30	39·1	41·1	+ 5·0	27·2	9·9	−17·3	Fog in morning; a fine day, clear sky	Thin fog in morning; a fine day.
31	46·0	49·2	+ 3·2	21·2	11·8	− 9·4	Fine and bright all day; haze	Few clouds all day; slight haze.
Means -	41·4	41·3	+ 2·9	18·0	11·4	− 6·6		
Nov. 1	37·0	44·6	+ 7·6	25·1	19·1	− 6·0	Cloudless all day; haze and mist in evening	Morning foggy; fine; evening hazy.
2	41·3	45·1	+ 3·8	17·7	17·3	− 0·4	Overcast and fog in morning; haze and mist	Fog and haze in morning; partially overcast.
3	39·3	44·3	+ 5·0	12·2	10·3	− 1·9	Clear; sunshine; haze prevalent	Fine day; few light clouds.
4	35·6	38·3	+ 2·7	16·4	12·3	− 4·1	Sky partially covered; haze and thin rain	Hazy and cloudy all day; rain in evening.
5	40·5	43·5	+ 3·0	16·0	11·0	− 5·0	Cloudy all day; hazy	Morning overcast; afternoon clear.
6	36·0	40·1	+ 4·1	16·5	14·2	− 2·3	Sky clear all day; fog at night	Fine day; sky clear; hazy.
7	31·0	35·8	+ 4·8	19·5	13·4	− 6·1	Sky partially covered; fog and haze prevalent	Fog in morning; overcast.
8	35·2	38·1	+ 2·9	15·3	8·7	− 6·6	Sky cloudy; fog and haze prevalent	Overcast and hazy all day.
9	34·4	35·1	+ 0·7	10·6	9·4	− 1·2	Clear sky; sunshine; rain in afternoon	Very fine day; few clouds.
10	27·5	29·5	+ 2·0	18·5	14·0	− 4·5	Sky generally overcast all day	Overcast all day; light fog and haze.
11	33·3	36·5	+ 3·2	15·7	13·0	− 2·7	Cloudy sky; sunshine; rain in evening	Overcast; thick atmosphere; haze.
12	35·5	—	—	10·7	—	—	Haze in morning; afternoon clear	Haze prevalent; fine, but cloudy.
13	28·9	32·0	+ 3·1	19·1	12·3	− 6·8	Cloudy all day; afternoon misty	Fog in morning, afternoon clear.
14	35·0	38·1	+ 3·1	7·2	8·8	+ 1·6	Fog in morning; cloudy; rain	Sky overcast; rain.
15	31·9	33·3	+ 1·4	20·1	13·9	− 6·2	Overcast, and fog during morning; rain	Overcast all day; rain.
16	37·0	40·2	+ 3·2	15·0	7·8	− 7·2	Overcast all day; rain and fog prevalent	Mist; sky partially covered; slight rain.
17	33·8	37·3	+ 3·5	12·7	10·9	− 1·8	Sky overcast; rain	Fog in morning; overcast; rain.
18	38·3	39·1	+ 0·8	5·9	7·4	+ 1·5	Sky partially cloudy all day	Cloudy during morning; afternoon fine.
19	34·5	36·6	+ 2·1	8·7	6·9	− 1·8	Morning cloudy; afternoon sunshine, fine	Haze prevalent all day.
20	34·7	35·0	+ 0·3	7·5	8·3	+ 0·8	Overcast all day; rain and sleet at noon	Fine day; haze prevalent.
21	35·4	36·1	+ 0·7	8·8	5·5	− 3·3	Overcast all day; rain occasionally	Sky partially covered; rain in afternoon.
22	33·2	35·1	+ 1·9	10·8	8·4	− 2·4	Clear till 10; overcast afterwards	Fine day; haze.
23	30·4	32·0	+ 1·6	7·1	8·8	+ 1·7	Sunshine till 11; fog and sky overcast afterwards	Overcast; fog and haze.
24	27·5	32·1	+ 4·6	15·7	7·1	− 8·6	Overcast all the day; mist falling	Fine; haze; rain.
25	31·4	32·5	+ 1·1	9·6	8·0	− 1·6	Overcast all day; occasional slight rain; haze	Overcast all day; haze; rain.
26	30·2	29·9	− 0·3	9·2	10·2	+ 1·0	Fine till noon; overcast afterwards	Morning very fine; afternoon partially overcast.
27	26·5	27·8	+ 1·3	13·8	9·4	− 4·4	Cloudless; fog prevalent all day; snow in afternoon	Fog and hoar frost; snow in afternoon.
28	26·6	28·9	+ 2·3	11·4	11·6	+ 0·2	Overcast all the day; rain in evening	Overcast all day; rain in afternoon.
29	39·0	37·6	− 1·4	10·0	9·4	− 0·6	Morning clear; afternoon cloudy and rain	Morning nearly cloudless; high wind.
30	33·8	39·5	+ 5·7	10·2	8·5	− 1·7	Morning cloudless; rain in afternoon; fog	Morning nearly cloudless; afternoon overcast.
Means -	33·3	36·7	+3·4	14·2	10·3	− 3·9		

TABLE XVI.—Showing the Lowest Temperature of the Air for every Day from July 1 to December 31, &c.—*cont.*

1854. — Month and Day.		Temperature of the Air. Lowest at Night. Lewisham.	Temperature of the Air. Lowest at Night. St. Thomas's Hospital.	Excess at St. Thomas's Hospital.	Range of Temperature in the Day. Lewisham.	Range of Temperature in the Day. St. Thomas's Hospital.	Excess at St. Thomas's Hospital.	General Remarks. Boundary Stations.	General Remarks. Central Stations.
Dec.	1	38°·7	38°·4	− 0°·3	12°·3	10°·2	− 2°·1	Morning cloudless; afternoon cloudy	Partially overcast all day; mist.
	2	34·3	35·6	+ 1·3	10·7	10·2	− 0·5	Fine day; partially cloudy; faint sunshine	Partially overcast all day; clear.
	3	37·2	37·1	− 0·1	12·6	9·9	− 2·7	Overcast till evening, clear afterwards	Partially overcast; clear.
	4	41·7	41·3	− 0·4	8·5	7·3	− 1·2	A fine day; cloudless till evening	Partially overcast; clear and bright.
	5	41·5	46·0	+ 4·5	8·5	4·2	− 4·3	Sky partially cloudy all day	Morning clear; afternoon overcast, and rain.
	6	34·3	35·6	+ 1·3	11·2	15·6	+ 4·4	A fine day; amount of cloud variable	Sky partially overcast; morning clear; afternoon hazy.
	7	34·8	34·5	− 0·3	7·2	10·1	+ 2·9	Sky mostly cloudless; thick haze prevalent	Clear sky; and haze prevalent all day.
	8	28·5	32·4	+ 3·9	21·0	13·6	− 7·4	Sky cloudy all day; rain	Overcast, and mist all day.
	9	35·3	40·8	+ 5·5	9·7	8·5	− 1·2	Morning cloudy; afternoon clear; haze	Light clouds; mist; afternoon clear; haze in distance.
	10	30·0	31·2	+ 1·2	10·0	12·4	+ 2·4	Clear; sky cloudless; haze at a distance	Light clouds all day; mist and haze.
	11	24·5	27·5	+ 3·0	20·4	11·0	− 9·4	Day cloudless; evening overcast; haze	Morning, clear sky and hoar frost; afternoon, overcast.
	12	27·6	35·2	+ 7·6	17·9	9·4	− 8·5	A fine day; sky cloudless; haze in distance	Very fine day; clear sky; mist.
	13	34·7	35·2	+ 0·5	17·3	10·4	− 6·9	A dull day; sky overcast; haze in distance	Morning foggy; afternoon overcast; mist and haze.
	14	45·6	41·3	− 4·3	9·2	13·0	+ 3·8	Overcast till evening; clear afterwards; haze	Overcast; haze prevalent.
	15	44·5	48·3	+ 3·8	9·5	7·1	− 2·4	A fine day; sky partially cloudy; haze prevalent	Sky partially cloudy; morning clear and bright.
	16	38·0	43·8	+ 5·8	15·0	10·8	− 4·2	Cloudy sky; haze prevalent; evening clear	Partially overcast; mist; and haze.
	17	31·0	34·5	+ 3·5	13·0	14·5	+ 1·5	Sky clear till noon; overcast afterwards	Morning fine; afternoon cloudy.
	18	32·8	37·2	+ 4·4	12·0	10·8	− 1·2	Morning overcast and showery; afternoon cloudy	Rain in morning; afternoon fine; haze.
	19	31·8	31·6	− 0·2	10·2	9·8	− 0·4	Morning clear; afternoon cloudy, and thin fog	Fine day; partially overcast; haze.
	20	34·1	32·7	− 1·4	8·9	10·7	+ 1·8	Morning overcast and rain; evening nearly cloudless	Overcast all day; rain.
	21	28·0	31·2	+ 3·2	14·5	13·4	− 1·1	Sky overcast; frequent showers of rain	Foggy; overcast all day; rain.
	22	41·0	36·2	− 4·8	13·2	17·2	+ 4·0	Sky overcast throughout the day; strong wind	Overcast throughout the day; mist and haze.
	23	37·0	40·8	+ 3·8	9·4	13·2	+ 3·8	Sky partially cloudy all day; rain in evening	Fine day; partially overcast; haze.
	24	35·0	36·0	+ 1·0	11·0	18·1	+ 7·1	Sky covered with cloud all day; distance hazy	Foggy; cloudy all day; mist.
	25	40·0	39·0	− 1·0	14·5	15·3	+ 0·8	Sky overcast all day; showery; distance clear	Cloudy and dull; rain.
	26	37·2	36·3	− 0·9	8·1	17·8	+ 9·7	Sky nearly clear all day; haze in distance	Very fine day; clear and bright; few clouds.
	27	34·0	33·3	− 0·7	10·4	12·2	+ 1·8	Sky partially cloudy; evening overcast	Fine day; partially cloudy; haze.
	28	30·5	30·2	− 0·3	7·0	10·6	+ 3·6	Sky generally clear all day; thin haze prevailed	Fine day; light clouds; slight fog and haze.
	29	27·5	29·4	+ 1·9	13·0	8·8	− 4·2	Sky overcast; mist and haze	Foggy; sky cloudy; haze.
	30	33·2	33·9	+ 0·7	13·2	11·2	− 2·0	Sky partially cloudy; mist and haze	Sky overcast all day; thick haze.
	31	35·0	31·4	− 0·6	12·5	12·1	− 0·4	Cloudy day; showers; haze in distance	Morning overcast and haze; rain in afternoon.
Means		34·8	36·1	+ 1·3	12·0	11·6	− 0·4		

The numbers in the second and third columns of this Table give the lowest temperatures of the air every day at Lewisham and at St. Thomas's Hospital, and the numbers in the fourth column exhibit the difference between the numbers in the two preceding columns, affixing the sign + when the temperature at St. Thomas's Hospital was the higher of the two. An inspection of the numbers in the third column will show that the night temperature of London has been almost always above that of the country. At times these excesses have amounted to 7°, 8°, 9°, and 10°. These large differences have occurred when the sky has been cloudless, with a hazy or misty atmosphere, with little or no wind, and when objects at the outlying stations have been seen at considerable distances, whilst near objects at the central stations have been obscure and ill-defined, clearly showing the effect of the city on the overhanging atmosphere, dimming its transparency, and creating around itself an atmosphere of comparative warmth and impurity. At times these differences have been small, and have mostly taken place when the sky has been overcast and rain falling.

The periods when the greatest excesses of night temperature occurred, were from August 26 to September 14, and from September 26 to October 4. These periods were both distinguished by a stagnant atmosphere, with prevalence of haze and frequent fog. The mean excess in the former period was 7°, and in the latter was 6·7°.

The numbers in the fifth and sixth columns give the daily range of temperature at Lewisham and St. Thomas's Hospital. The numbers in the last column exhibit the difference of daily range on every day at the two places, the sign — being affixed to those numbers when the range in London has been less than in the country. An inspection of the numbers in the last column will show that, with very few exceptions, the sign — is affixed, showing that the range of daily temperature in London has been almost always smaller than that of the country. At times the daily range has been the half only of that in the country, and at times the difference has amounted to 15° and 20°; at such times the air has been calm, with a thick atmosphere; fog, mist, or haze has been prevalent.

The most continuous large defects of daily range took place from August 26 to September 11, and from September 26 to October 4. In the former period the diurnal range of temperature at Lewisham was 32·5°, and at St. Thomas's Hospital was 17·5°; and in the latter period was at Lewisham 31·2°, and at St. Thomas's Hospital 14·9°.

In these particulars London climate differs greatly from that of the country. The condition of a low day temperature, of a high night temperature, and of a small range of daily temperature, are those favourable to the prevention and cure of pulmonary complaints. London climate would, therefore, seem to include these conditions; but then, on the other hand, it is necessary they should be accompanied by a pure atmosphere.

It remains now only to compare the monthly diurnal range in 1854 with its *normal* amount at one station. The following Table contains the results of the observations at Greenwich since the year 1841.

TABLE XVII.—MONTHLY RANGE of TEMPERATURE at the ROYAL OBSERVATORY, GREENWICH, for the YEARS 1841 to 1854.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°		°	°	°	°	°
1841	11·1	9·1	17·5	16·5	21·3	18·8	15·6	16·3	16·0	11·7	10·7	9·4
1842	6·4	10·4	10·9	16·1	16·7	22·2	17·7	20·3	12·8	13·2	7·9	8·2
1843	7·9	7·5	12·4	15·4	14·7	15·2	15·6	16·4	17·4	12·8	10·2	6·6
1844	8·7	10·5	12·1	21·0	18·6	19·9	16·2	15·4	15·3	12·4	7·4	5·4
1845	6·4	8·7	11·1	16·8	14·2	18·2	14·8	14·9	15·6	13·3	10·9	9·9
1846	7·7	8·3	12·7	13·1	16·6	22·5	17·5	15·5	18·0	10·4	8·0	10·3
1847	8·8	11·6	16·0	18·3	21·2	19·4	23·3	21·0	18·7	14·0	11·4	9·7
1848	8·3	10·7	14·3	16·7	30·5	17·7	22·5	18·5	20·9	16·5	15·7	12·7
1849	10·8	12·9	13·8	16·0	16·3	20·6	22·6	20·2	17·5	15·1	11·7	9·1
1850	8·5	11·6	16·4	16·0	18·9	26·0	20·0	18·6	17·1	14·2	11·4	8·7
1851	10·0	13·2	12·1	16·2	19·6	22·1	20·1	20·0	20·6	13·0	11·9	8·0
1852	11·4	12·2	18·6	24·0	18·6	17·1	24·9	17·9	17·4	14·6	10·4	9·7
1853	10·1	10·1	16·1	14·2	21·2	18·7	17·1	19·1	18·0	15·2	11·5	9·3
Means -	8·2	10·5	14·2	16·9	19·1	19·8	17·5	18·0	17·3	13·6	10·7	9·0
1854 -	10·8	13·6	19·2	23·7	21·3	19·2	21·6	20·7	25·7	17·5	12·7	11·0
Excess in 1854 -	+ 2·6	+ 3·1	+ 5·0	+ 6·8	+ 2·2	– 0·6	+ 4·1	+ 2·7	+ 8·4	+ 3·9	+ 2·0	+ 2·0

The numbers in the lowest line but two give the mean monthly diurnal range for the preceding 13 years; the lowest line but one gives the observed daily range in 1854; and the lower line of all gives the abnormal values for 1854. These are all, with one exception, affected with the + sign, the month of June forming the exception. The whole year seems to be remarkable in this respect. The months whose daily ranges have been the greatest are March and April, and September the greatest of all. The mean yearly daily range for the 13 years ending 1853 was 14·6°, and for the year 1854 was 18·1°, being 3·5° above the average.

Temperature of the Thames Water.

Thus far I have proceeded in strict conformity with the rules applying to meteorological investigation; but as, during the progress of my work, I have found it intimately linked with a number of influences in operation to produce the abnormal condition which each Table exhibits, to a more or less extent, as existing in London and its suburbs, I have felt myself bound to ascertain as much as possible the nature of these influences, and to connect them all in my power with the main object of my report. I hope, therefore, that so doing I may not be considered to transgress the precise limits of my own share of this most important and onerous investigation.

As air is the receptacle for all vapours and impurities arising from evaporation and exhalation, it is necessary, before proceeding farther in this inquiry, to investigate the temperature of the Thames water, which presents a large evaporating surface, giving off vapour day and night in immense quantities.

As the river will be found to exercise an important, and, unfortunately, a most baneful influence upon London meteorology, I propose in the following discussion to avail myself of a series of observations which have been made by Captain Sanders, R.N. since the year 1846.*

His instruments consist of a maximum thermometer, as patented by Negretti and Zambra, and a minimum thermometer of Rutherford's construction. These instruments are placed in a perforated trunk, fixed to the side of the "Dreadnought" Hospital ship, lying off Greenwich, at the depth of two feet below the surface of the water. The diurnal range of the temperature of the water is small, and its temperature is well determined by one set of observations daily. The results from 9 years are contained in the following Table:—

* See Greenwich Observations.

TABLE XVIII.—MEAN MONTHLY TEMPERATURES of the WATER of the THAMES.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°	°	°	°	°	°	°
1846	43·2	43·9	47·3	50·5	58·6	71·9	66·7	67·5	64·1	53·5	46·8	36·3
1847	36·3	38·1	41.8	46·7	57·8	63·7	68·6	65·3	56·8	53·2	47·6	42·0
1848	35·4	41·1	..	50·6	61·8	63·1	65·5	62·5	59·1	52·2	..	42·2
1849	40·6	43·4	44·9	46·3	57·3	64·3	67·0	63·8	60·0	51·2	45·6	38·6
1850	32·4	41·3	41·2	48·4	54·3	63·7	64·6	63·2	57·9	49·3	46·0	39·1
1851	41·2	40·2	41·7	49·8	54·5	61·9	65·5	66·5	60·0	55·0	42·3	42·1
1852	40·7	41·3	41·9	48·2	54·8	59·3	66·0	62·4	57·7	49·4	48·2	45·5
1853	42·5	37·6	40·4	48·4	55·1	61·3	63·7	63·6	58·2	53·1	45·5	38·5
1854	38·2	41·6	45·5	52·2	54·9	59·1	64·1	64·1	62 9	54·1	45·5	41·7
Means -	38·9	40·9	43·1	49·0	56·6	63·2	65·7	64·3	59·6	52·1	46·0	40·5
Excess above Air Temp. of the same year -	− 0·3	+ 0·5	+ 1·2	+ 2·8	+ 3·1	+ 4·3	+ 3·1	+ 2·9	+ 2·7	+ 1·4	+ 0·1	+ 0·4

In the last two lines of this Table are given the mean results for each month, and the excess of the temperature of the water above that of the air, in the same period of nine years. We learn from them that the temperature of the water has been higher than that of the air in every month except January. The excess is 0·5° in February, increasing to 4·3° in June, decreasing to 3·1° in July, continuing about this value till September; is 1·4° in October, and less than 0·5° in the remaining two months.

The mean excess in the months from April to September is 3·3, and 0·6° in the remaining month.

The *normal* temperature of the water of the Thames for the entire year from these results is 51·7°. By taking the difference between this result and the monthly means, the law of *annual variation* of Thames water temperature is found to be as follows:—

January, −12·8°; February, −10·8°; March, −8·6°; April, −2·7°; May, +4·9°; June, +11·5°; July, +14·0°; August, +12·6°; September, +7·9°; October, +0·4°; November, −0·7°; December, −11·2°.

The observations of 1854 may be discussed as follows:—

The mean temperature of the water of the Thames for the year 1854 was 52·0°, exceeding the average by 0·3°. By taking the difference between the mean for the entire year, and that of each month, the variation for the year 1854 is found as follows:—

January, −13·8°; February, −10·4°; March, −6·5°; April, +0·2°; May, +2·9°; June, +7·1°; July, +12·1°; August, +12·1°; September, +10·9°; October, +2·9°; November, −6·5°; and December, −10·3°.

By comparing these numbers with the law of diurnal variation, we shall see that they depart from that law, particularly in March, April, June, September, and October.

The excess of the temperature of the Thames water in the year 1854, above that of the superincumbent air, was as follows:—

January, −0·8°; February, +2·1°; March, +1·7°; April, +3·8°; May, +4·0°; June, +3·4°; July, +3·8°; August, +3·2°; September, +4·8°; October, +4·6°; November, + 5·0°; and December, +0·4°.

By the comparison of these numbers with those in the lower line of the preceding Table, it will be seen that the relation between the temperatures of the water and air in 1854 has not been the same as the averages. The excesses were a little smaller in June, July, and August; they were larger in February, March, and April, and very much larger in the months of September, October, and November. The heating effect, therefore, of the water upon the air in these months in the year 1854 must have been much greater than usual.

The temperature of the water of the Thames being in excess of the temperature of the air, accounts in a great measure for the high night temperature of London already noticed. In the same manner as the thick atmosphere of the Metropolis by day, opposes a screen to the full influence of light and heat, it is equally obvious that the air at night must have it raised by contact with the water, which the

foregoing Tables have shown to be at a higher temperature. Of the baneful effects of the Thames water and its adjacent marshes upon the climate and health of London I will endeavour to convey an idea as I proceed, with as much minuteness as may be consistent with a report devoted to other subjects of inquiry, and I shall be able to show distinctly that the impurities with which the river is at present charged, through an imperfect and much to be regretted sanatory arrangement, have chiefly to answer for the atmosphere of death and disease with which certain districts of the metropolis are invested, and which can only be removed by the cessation of the obnoxious influences.

It is much to be regretted that these should be suffered to arise from the very source of the prosperity and commercial greatness of a city, which it has contributed to render the greatest in the world; whose waters, if suffered to flow undefiled with the sewerage of a vast city, instead of acting as a laboratory for the general diffusion of noxious vapours, would, in their course exercise a healthful and purifying influence.

I will now proceed to discuss the mean daily temperature of the Thames water from July to the end of the year, as shown in the following Table.

Table XIX.—Mean Daily Temperature of the Water of the Thames.

1854. Month and Day.	Mean Daily Temp.	1854. Month and Day.	Mean Daily Temp.	1854. Month and Day.	Mean Daily Temp.	1854. Month and Day.	Mean Daily Temp.	1854. Month and Day.	Mean Daily Temp.	1854. Month and Day.	Mean Daily Temp.	1854. Month and Day.	Mean Daily Temp.
	°		°		°		°		°		°		°
June 1	57·8	July 1	62·9	Aug. 1	67·3	Sept. 1	64·8	Oct. 1	59·0	Nov. 1	49·3	Dec. 1	41·5
2	58·1	2	62·6	2	66·8	2	63·4	2	58·5	2	49·7	2	41·4
3	[illegible]	3	63·4	3	65·7	3	66·3	3	58·0	3	49·5	3	41·4
4	57·6	4	63·6	4	63·4	4	65·1	4	58·2	4	49·2	4	41·4
5	[illegible]	5	63·2	5	63·5	5	65·3	5	57·7	5	49·4	5	41·6
6	56·7	6	62·7	6	62·7	6	65·4	6	57·6	6	48·5	6	41·7
7	56·2	7	62·7	7	62·5	7	64·8	7	57·4	7	48·2	7	41·6
8	55·8	8	62·4	8	62·7	8	65·3	8	57·1	8	47·9	8	41·5
9	55·8	9	62·7	9	62·9	9	64·0	9	57·4	9	47·0	9	41·6
10	56·1	10	62·4	10	63·5	10	63·4	10	56·7	10	46·8	10	41·3
11	56·3	11	62·7	11	63·7	11	63·4	11	56·8	11	46·8	11	41·1
12	57·2	12	62·5	12	63·8	12	63·4	12	56·6	12	46·3	12	41·1
13	57·3	13	62·6	13	64·3	13	63·5	13	56·2	13	46·1	13	41·7
14	57·3	14	62·6	14	65·4	14	63·6	14	55·7	14	45·9	14	41·2
15	57·8	15	62·6	15	64·8	15	63·6	15	55·3	15	45·7	15	42·3
16	[illegible]	16	62·3	16	64·5	16	63·6	16	54·6	16	45·5	16	42·8
17	[illegible]	17	[illegible]	17	64·1	17	63·7	17	56·8	17	45·3	17	42·1
18	[illegible]	18	[illegible]	18	63·6	18	63·6	18	53·1	18	44·8	18	41·3
19	[illegible]	19	[illegible]	19	63·1	19	64·4	19	[illegible]	19	44·8	19	41·0
20	[illegible]	20	[illegible]	20	[illegible]	20	64·1	20	52·3	20	43·2	20	41·5
21	[illegible]	21	[illegible]	21	[illegible]	21	[illegible]	21	52·6	21	44·0	21	41·4
22	[illegible]	22	[illegible]	22	[illegible]	22	[illegible]	22	[illegible]	22	43·3	22	41·4
23	[illegible]	23	[illegible]	23	[illegible]	23	[illegible]	23	51·5	23	43·1	23	41·7
24	[illegible]	24	[illegible]	24	[illegible]	24	[illegible]	24	[illegible]	24	42·8	24	42·3
25	[illegible]	25	[illegible]	25	[illegible]	25	[illegible]	25	[illegible]	25	42·5	25	42·3
26	[illegible]	26	[illegible]	26	[illegible]	26	[illegible]	26	[illegible]	26	[illegible]	26	42·5
27	[illegible]	27	[illegible]	27	[illegible]	27	[illegible]	27	[illegible]	27	[illegible]	27	42·4
28	[illegible]	28	[illegible]	28	[illegible]	28	[illegible]	28	[illegible]	28	41·6	28	42·1
29	[illegible]	29	[illegible]	29	[illegible]	29	[illegible]	29	[illegible]	29	41·6	29	42·0
30	[illegible]	30	[illegible]	30	[illegible]	30	[illegible]	30	[illegible]	30	42·5	30	41·8
		31	[illegible]	31	[illegible]			31	[illegible]			31	42·0

From this Table [illegible] the Thames [illegible] June 27; it [illegible] the middle [illegible] highest in the year, [illegible] this time it [illegible]

decreased to 62° by the 8th and 9th of August, and varied but little till towards the end of the month, when a singular increase took place, and a second maximum, viz., 66°, occurred at the beginning of September; it then declined gradually, but with some fluctuations, to 60° by the 25th of September, then to 50° by October 27, and to 42° by November 26. After this time to the end of the year there was scarcely any variation of temperature.

The daily range of temperature of the Thames water is about 2°; by decreasing the numbers in the preceding Table by 1°, we shall have the lowest night temperature of the Thames water; and by comparing these numbers with the lowest night temperatures at Lewisham in Table XVI., the difference is determined between the temperature of the water at night and the air in its vicinity just beyond its influence. The results of this calculation are shown in the next Table.

TABLE XX.—Showing the EXCESS of the NIGHT TEMPERATURE of the WATER of the THAMES above the MINIMUM TEMPERATURE of the AIR.

Day of Month.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°
1	+10·4	+ 8·2	+19·6	+17·8	+11·3	+ 1·8
2	+11·6	+16·6	+17·9	+18·5	+ 7·4	+ 6·1
3	+ 7·9	+10·2	+22·0	+12·1	+ 9·2	+ 6·2
4	+ 6·6	+15·1	+19·0	+18·6	+12·6	− 1·3
5	+12·4	+11·0	+19·4	+ 7·3	+ 7·9	− 0·9
6	+11·4	+10·5	+20·2	+ 4·7	+11·5	+ 6·4
7	+16·8	+ 7·0	+19·7	+ 9·7	+16·2	+ 5·8
8	+ 9·5	+12·5	+16·0	+ 8·6	+11·7	+12·0
9	+13·9	+10·5	+14·2	+ 4·3	+11·6	+ 5·3
10	+12·5	+ 7·5	+21·9	+ 7·9	+18·3	+10·3
11	+11·2	+10·2	+22·3	+ 3·7	+12·5	+15·6
12	+10·9	+ 5·5	+24·5	+19·1	+ 9·8	+12·5
13	+12·9	+11·8	+ 9·7	+22·5	+16·2	+ 6·0
14	+11·6	+ 7·3	+ 8·6	+17·1	+ 9·9	− 5·4
15	+ 7·3	+12·6	+ 9·3	+ 5·8	+12·8	− 3·2
16	+10·5	+15·3	+ 3·5	+10·1	+ 7·5	+ 3·8
17	+ 7·5	+18·1	+ 9·7	+19·7	+10·5	+10·1
18	+ 9·9	+19·4	+12·0	+ 8·3	+ 5·5	+ 7·5
19	+12·1	+14·9	+ 4·5	+15·0	+ 9·3	+ 8·2
20	+11·5	+17·2	+13·1	+10·7	+ 7·5	+ 6·4
21	+13·8	+ 9·4	+17·2	+ 7·7	+ 7·6	+12·4
22	+12·7	+13·4	+21·4	+ 3·4	+10·3	− 0·6
23	+15·6	+16·0	+12·3	+13·3	+11·7	+ 3·7
24	+13·4	+ 8·3	+ 6·2	+14·9	+14·3	+ 6·3
25	+ 9·7	+11·2	+16·2	+ 9·9	+10·1	+ 1·3
26	+10·0	+18·3	+18·6	+14·5	+11·0	+ 4·3
27	+11·6	+ 9·0	+17·9	+19·3	+14·2	+ 7·4
28	+14·3	+ 1·6	+16·9	+13·5	+14·0	+10·6
29	+23·2	+12·2	+21·3	+14·0	+ 1·6	+13·5
30	+10·2	+13·2	+18·8	+ 9·2	+ 6·7	+ 7·6
31	+ 8·2	+ 9·8		+ 2·0		+ 6·0

It will be observed that the numbers in this Table are frequently very large, so large indeed that we may infer the water to have been simmering and giving off volumes of vapour, thus, furnishing an explanation of the fact of less daily range of temperature in London

and the frequent prevalence of fog and mist, which, in connexion with the marshes, are very sufficiently accounted for over the city and its environs.

It appears that the most continuously large excesses took place between August 15 and September 12, when during this period of 28 consecutive nights, the average excess was 16·3°; and again, within the period beginning September 20 and ending October 4, the mean excess was 16·5°.

Within these periods the whole area of the Thames must have been giving off incessant and vast volumes of vapour, which, unsustained by air, because of the great difference of temperature, hovered over the city, thickening the atmosphere and exercising an influence most inimical to the health of the Metropolis.

Humidity of the Air.

The following Tables give the results of the dry and wet-bulb thermometers; the observations with these instruments were exclusively made during the day. Table XXI. contains the weekly means of the temperatures of evaporation at the several stations; Table XXII. those of the dew point; and Table XXIII. contains the tension of vapour. These several results were calculated from my hygrometrical Tables.

TABLE XXI.—WEEKLY MEAN TEMPERATURES of EVAPORATION.

NAME OF STATION.	WEEK ENDING																									
	JULY				AUGUST				SEPTEMBER					OCTOBER				NOVEMBER				DECEMBER				
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Sydenham	..	..	..	..	..	..	..	..	..	..	57·6	52·7	51·3	51·1	48·6	43·5	42·7	47·1	38·9	39·0	35·3	..	39·8	42·0	..	35·3
Lewisham	54·1	53·9	56·2	59·1	56·8	56·4	54·7	56·2	59·0	55·5	56·9	54·7	51·6	50·2	49·3	44·9	43·3	47·4	40·9	40·1	35·4	37·3	40·1	40·2	38·7	38·7
Royal Observatory	53·6	53·9	57·4	58·8	56·7	56·7	55·1	55·7	59·0	54·0	57·0	53·8	51·2	51·0	49·3	44·6	42·4	47·3	40·7	39·4	35·4	36·6	40·3	41·0	39·2	38·2
Bexley Heath	..	..	..	..	..	..	..	..	59·0	53·1	55·8	55·1	51·2	52·2	49·6	44·3	42·7	47·4	40·4	40·7	35·4	40·0	40·6	41·0	39·4	37·4
Brixton Road	..	..	..	..	..	..	..	..	58·1	53·9	57·7	52·2	52·6	50·7	49·0	43·0	43·0	48·2	40·7	41·2	35·7	..	..	..	..	..
Camberwell	..	..	..	..	..	..	..	..	..	..	57·9	54·4	50·3	51·3	49·9	45·0	43·8	47·6	41·2	..	..	40·5	39·8	40·7	38·0	..
Dreadnought	..	..	..	..	..	..	..	..	..	..	59·1	48·5	..	54·6	52·2	47·3	46·1	50·3	44·5	43·4	39·9	..	..	..	..	..
Millbank	..	..	..	..	..	..	..	..	..	..	..	54·9	50·9	50·6	49·0	45·8	43·3	47·6	41·3	40·4	36·2	36·3	41·6	40·7	39·5	37·3
Brompton	..	..	..	..	..	..	..	..	..	..	..	53·1	49·9	50·9	48·3	44·2	42·3	46·7	41·2	40·4	36·3	36·0	41·2	41·6	41·6	..
Board of Health	..	..	..	..	..	..	..	..	..	53·9	55·8	54·7	51·1	51·3	48·4	43·7	42·6	47·2	40·9	41·6	37·4	37·4	39·2	41·2	38·7	36·0
St. Thomas' Hosp.	53·6	54·9	57·8	59·3	56·7	56·1	56·0	57·7	57·9	53·7	57·1	54·3	51·1	50·9	49·2	44·8	42·2	47·9	41·0	40·6	36·0	37·3	41·6	41·0	40·2	39·8
Poplar	..	..	..	..	..	..	..	..	..	..	58·4	56·3	51·6	51·8	50·4	44·5	43·1	47·5	41·6	41·0	37·4	37·7	40·4	43·6	39·7	39·0
Guildhall	..	..	..	..	..	..	..	..	..	..	..	..	51·3	52·7	50·0	44·5	43·7	48·1	41·5	42·0	36·5	38·0	..	..	..	..
Somerset House	..	..	..	..	..	..	..	..	..	..	58·5	51·3	50·8	50·6	48·3	43·3	43·1	47·9	41·6	41·4	35·5	36·8	40·6	40·8	39·0	39·9
St. Giles	..	..	..	..	..	..	..	..	..	..	..	54·4	52·9	53·6	51·8	46·3	44·8	49·9	42·3	..	..	..	..	..	..	..
Chiswell Street	..	..	..	..	..	..	..	..	63·7	58·3	58·3	56·6	53·8	..	51·5	45·5	44·6	50·0	..	..	..	..	..	..	..	..
St. Mary's Hosp.	32·8	53·7	59·6	60·2	56·4	56·1	54·7	56·0	59·5	53·5	57·9	54·7	54·3	51·6	49·0	44·6	43·4	48·6	41·0	40·2	36·2	36·8	41·0	41·1	39·4	39·3
Bethnal Green	..	..	..	..	..	..	..	..	..	..	..	51·3	50·6	51·3	47·6	44·0	42·7	47·9	39·8	40·3	35·7	37·7	40·0	42·6	..	..
St. John's Wood	52·6	53·4	57·3	58·7	56·3	56·1	54·2	55·2	59·7	54·4	56·2	..	..	..	..	..	..	..	..	39·2	35·0	35·5	39·6	39·6	38·0	37·1
St. Pancras	..	..	..	..	..	..	..	..	..	..	..	53·4	48·7	49·5	47·0	43·3	43·4	47·7	41·2	40·8	..	..	..	..	..	..
Highgate	..	..	..	..	..	..	..	..	..	..	57·1	54·9	52·6	51·7	50·0	46·5	44·2	47·8	41·3	39·4	35·5	36·3	40·7	40·7	..	38·2
Enfield Vicarage	53·0	52·2	54·1	57·0	55·4	52·6	..	54·4	..	..	50·1	53·4	48·0	50·0	47·8	42·5	42·6	44·8	39·3	38·5	..	35·7	38·9	39·3	36·8	35·5
Means	53·3	53·7	56·1	58·9	56·4	55·7	54·9	55·9	58·2	54·5	56·9	53·6	52·3	51·9	49·3	44·6	43·3	47·9	41·2	40·5	36·3	37·2	40·3	41·1	39·1	37·8

TABLE XXII.—Weekly Mean Temperatures of the Dew Point.

Name of Station.	Week ending																									
	July				August				September					October				November				December				
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Sydenham	..	..	..	..	..	..	..	..	..	..	55·7	32·1	48·2	48·2	46·7	41·3	40·4	45·1	35·1	36·8	34·5	..	37·0	..	39·4	32·2
Lewisham	50·8	51·5	51·0	54·6	54·4	53·2	50·6	52·4	55·0	51·5	54·3	52·3	47·9	45·8	46·8	42·6	40·6	44·3	39·0	38·5	33·6	34·6	37·4	37·9	36·8	36·6
Royal Observatory	51·6	51·6	53·4	54·5	55·1	54·0	51·2	51·8	58·4	50·1	53·8	50·9	47·2	48·1	47·6	42·3	39·1	44·7	38·6	37·5	33·7	34·0	37·7	38·5	37·3	35·9
Bexley Heath	..	..	..	..	..	..	..	..	56·2	49·0	52·7	52·1	47·4	49·3	47·5	40·7	39·3	45·2	38·3	38·5	33·8	37·0	37·7	38·3	36·3	34·5
Brixton Road	..	..	..	..	..	..	..	..	52·6	48·3	52·3	47·8	47·8	46·4	45·5	39·0	38·8	45·8	35·5	38·8	33·0	..	..	..	..	..
Camberwell	..	..	..	..	..	..	..	..	..	..	55·6	52·0	46·2	48·2	47·4	42·6	40·4	45·3	38·4	..	..	37·0	35·7	36·7	36·5	..
Dreadnought	..	..	..	..	..	..	..	..	..	..	57·6	56·7	..	53·3	51·0	44·0	42·5	47·3	41·2	41·1	37·1	..	..	..	..	..
Millbank	..	..	..	..	..	..	..	..	..	..	..	51·0	46·7	46·6	45·7	44·2	40·1	44·8	38·1	37·6	33·3	32·1	38·8	37·1	36·4	32·7
Brompton	..	..	..	..	..	..	..	..	..	..	..	49·1	45·9	47·6	45·0	40·5	39·5	44·2	38·5	37·6	33·7	32·2	38·2	38·1	38·8	..
Board of Health	..	..	..	..	..	..	..	..	..	48·6	51·6	50·9	47·6	48·0	44·6	40·0	40·2	44·3	38·1	40·1	37·0	33·9	34·8	37·5	35·0	32·6
St. Thomas' Hosp.	50·0	53·5	53·0	54·8	54·1	51·6	54·0	54·0	53·3	48·2	53·8	51·0	46·6	48·0	46·5	42·4	42·5	45·0	37·5	38·3	33·0	35·1	39·1	38·6	38·8	38·7
Poplar	..	..	..	..	..	..	..	..	..	..	55·7	53·8	49·0	49·2	48·9	41·8	40·2	46·0	40·0	39·6	36·8	36·3	38·8	42·6	38·8	37·8
Guildhall	..	..	..	..	..	..	..	..	..	..	..	..	49·0	49·4	46·8	40·8	40·2	46·1	37·5	40·1	35·0	35·0	..	..	..	..
Somerset House	..	..	..	..	..	..	..	..	..	..	55·5	46·6	46·5	46·1	43·9	37·0	39·8	44·2	37·9	39·1	32·4	32·6	36·0	36·8	36·1	38·0
St. Giles	..	..	..	..	..	..	..	..	..	..	..	51·5	49·7	51·6	50·2	45·3	43·7	46·0	40·9	..	..	..	..	..	..	..
Chiswell Street	..	..	..	..	..	..	..	..	61·6	54·7	54·9	54·6	50·1	..	48·6	40·7	40·3	48·5	..	..	..	..	..	..	..	..
St. Mary's Hosp.	48·8	50·7	58·5	55·9	54·4	52·0	50·9	52·2	55·8	52·0	55·1	52·0	51·3	47·3	45·0	41·0	40·1	45·2	37·6	37·0	33·7	33·6	37·3	36·7	36·9	36·6
Bethnal Green	..	..	..	..	..	..	..	..	..	..	..	45·1	45·3	47·0	42·6	40·1	39·1	44·8	35·7	37·5	33·3	34·6	35·4	39·3	..	..
St. John's Wood	48·0	50·9	53·4	54·5	55·1	52·7	51·2	54·4	56·6	49·5	53·5	..	..	..	..	..	..	..	..	36·7	32·7	32·4	36·6	36·5	35·3	34·8
St. Pancras	..	..	..	..	..	..	..	..	..	..	..	52·2	44·5	45·3	43·1	39·0	41·1	45·2	36·7	38·1	..	..	..	.	..	..
Highgate	..	..	..	..	..	..	..	..	..	..	54·5	51·8	47·7	48·4	47·0	44·9	41·1	45·6	39·0	37·6	35·5	34·0	38·5	38·3	..	36·5
Enfield Vicarage	48·5	48·5	48·5	52·1	51·5	49·8	..	49·7	..	..	45·0	49·1	43·5	47·0	44·7	39·3	39·1	42·8	36·4	35·7	..	32·0	35·6	37·9	34·2	31·4
Means	49·6	51·1	53·0	54·4	54·1	52·2	51·6	51·9	55·8	50·2	53·8	51·1	47·4	48·0	46·4	41·4	40·4	45·4	38·1	38·2	34·3	34·3	37·2	38·0	36·9	35·5

TABLE XXIII.—Weekly Means of Elastic Force of Vapour.

Name of Station.	Week ending: July 8	July 15	July 22	July 29	August 5	August 12	August 19	August 26	September 2	September 9	September 16	September 23	September 30	October 7	October 14	October 21	October 28	November 4	November 11	November 18	November 25	December 2	December 9	December 16	December 23	December 30
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Sydenham - -	..	..	..	..	..	..	..	..	..	..	·457	·402	·350	·350	·334	·276	·268	·316	·222	·236	·218	..	·238	·260	..	·200
Lewisham - -	·383	·394	·386	·437	·434	·417	·383	·402	·445	·394	·432	·404	·347	·322	·335	·289	·270	·307	·256	·251	·211	·220	·242	·245	·237	·235
Royal Observatory	·367	·396	·417	·443	·445	·427	·370	·393	·444	·406	·430	·384	·341	·354	·345	·286	·253	·311	·251	·240	·200	·214	·244	·251	·241	230
Bexley Heath -	..	..	..	..	..	..	..	..	·456	·360	·408	·400	·341	·364	·343	·271	·258	·317	·250	·251	·213	·240	·243	·248	·231	·218
Brixton Road -	..	..	..	..	..	..	..	..	·410	·354	·415	·346	·346	·331	·320	·253	·253	·323	·227	·254	·205	..	..	..	..	..
Camberwell -	..	..	..	..	..	..	..	..	..	..	·451	·400	·326	·350	·341	·290	·268	·318	·250	..	..	·238	·227	·235	·234	..
Dreadnought -	..	..	..	..	..	..	..	..	..	..	·480	·470	..	·418	·386	·304	·288	·341	·275	·274	·240	..	..	..	..	..
Millbank - -	..	..	..	..	..	..	..	..	..	..	..	·386	·334	·332	·322	·305	·265	·312	·247	·244	·209	·200	·248	·238	·232	·205
Brompton - -	..	..	..	..	..	..	..	..	..	..	..	·370	·325	·342	·315	·270	·260	·302	·251	·244	·212	·201	·248	·248	·253	..
Board of Health -	..	..	..	..	..	..	..	..	..	·356	·395	·386	·343	·348	·310	·264	·267	·308	·247	·265	·238	·213	·220	·242	·223	·204
St. Thomas' Hosp.	·373	·420	·413	·437	·431	·394	·427	·428	·424	·352	·425	·386	·332	·348	·331	·287	·289	·314	·242	·249	·207	·222	·258	·250	·254	·252
Poplar - - -	..	..	..	..	..	..	..	..	..	..	·469	·423	·360	·361	·364	·282	·267	·324	·263	·261	·236	·232	·253	·259	·253	·245
Guildhall - -	..	..	..	..	..	..	..	..	..	..	..	..	·357	·364	·335	·276	·270	·327	·243	·266	·222	·222	..	..	..	..
Somerset House -	..	..	..	..	..	..	..	..	..	..	·448	·331	·331	·326	·362	·237	·262	·406	·244	·255	·202	·206	·227	·238	·230	·246
St. Giles' - -	..	..	..	..	..	..	..	..	..	..	..	·393	·370	·394	·376	·317	·300	·325	·272	..	..	..	..	..	..	..
Chiswell Street -	..	..	..	..	..	..	..	..	·542	·348	·439	·436	·374	..	·355	·272	·267	·360	..	..	..	..	..	..	..	..
St. Mary's Hosp. -	·358	·380	·406	·457	·433	·400	·385	·402	·453	·400	·442	·400	·390	·340	·315	·273	·265	·316	·244	·239	·212	·211	·240	·235	·236	·235
Bethnal Green -	..	..	..	..	..	..	..	..	..	..	..	·316	·318	·336	·293	·265	·256	·312	·227	·242	·206	·217	·225	·256	..	..
St. John's Wood -	·349	·383	·418	·435	·442	·410	·390	·391	·466	·367	·426	..	..	..	..	..	..	..	..	·235	·204	·201	·234	·233	·225	·220
St. Pancras - -	..	..	..	..	..	..	..	..	..	..	..	·402	·308	·319	·294	·256	·276	·516	·236	·247	..	..	..	..	..	..
Highgate - -	..	..	..	..	..	..	..	..	..	..	·442	·398	·345	·352	·336	·313	·275	·320	·255	·244	·215	·214	·251	·249	..	·235
Enfield Vicarage -	·355	·353	·355	·400	·393	·370	..	·370	..	..	·315	·363	·298	·337	·310	·258	·256	·289	·232	·229	..	·200	·226	·245	·216	·195
Means - -	·368	·388	·441	·434	·429	·402	·394	·398	·455	·371	·425	·388	·342	·349	·330	·280	·268	·319	·247	·250	·215	·216	·239	·248	·236	·225

The lower line of each of these Tables gives the mean value in each week for the Metropolitan districts, and by comparing them with the numbers in the bodies of the Tables the differences will be found to be small and to follow no order, thus showing that the water mixed with the air during the hours of the day has been equally diffused throughout every district. The next Table contains the mean monthly temperatures of evaporation and dew point in 1854, compared with their mean values.

TABLE XXIV.—Showing the MONTHLY DIFFERENCE of the TEMPERATURES of EVAPORATION, DEW POINT, and ELASTIC FORCE of VAPOUR in the Year 1854.

MONTHS.	Temperature of Evaporation.			Temperature of Dew Point.			Tension of Vapour.		
	Average	In the year 1854.	Excess in 1854.	Average	In the year 1854.	Excess in 1854.	Average	In the year 1854.	Excess in the year 1854.
	°	°	°	°	°	°	in.	in.	in.
January - -	37·3	38·0	+0·7	35·2	36·1	+0·9	0·224	0·234	+0·010
February - -	37·3	37·5	+0·2	34·8	33·6	−1·2	0·223	0·218	−0·005
March -	41·1	40·9	−0·2	35·7	37·4	+1·7	0·229	0·236	+0·007
April - -	43·6	45·0	+1·4	40·3	41·1	+0·8	0·268	0·274	+0·006
May - -	49·6	48·6	−1·0	46·1	45·9	−0·2	0·329	0·327	−0·002
June - -	54·3	52·7	−1·6	51·2	50·0	−1·2	0·389	0·371	−0·018
July - -	57·4	56·2	−1·2	54·3	53·6	−0·7	0·438	0·413	−0·025
August - -	57·4	56·5	−0·9	54·5	53·3	−1·2	0·437	0·416	−0·021
September -	53·9	53·9	0·0	51·3	50·4	−0·9	0·392	0·375	−0·017
October - -	47·7	47·1	−0·6	45·4	44·5	−0·9	0·321	0·309	−0·012
November - -	42·7	39·4	−3·3	40·7	37·9	−2·8	0·273	0·245	−0·028
December - -	39·0	39·6	+0·6	36·9	37·0	+0·1	0·240	0·240	0·000

The prevalence of — signs in the 4th and last columns, in all except the winter months, show that there was less water in the air than usual, particularly in the month of November.

The following Table contains the weekly value of the relative humidity; the state of complete saturation being represented by 100:—

TABLE XXV.—WEEKLY MEANS of HUMIDITY of the AIR.

NAME OF STATION.	WEEK ENDING																									
	JULY				AUGUST				SEPTEMBER					OCTOBER				NOVEMBER				DECEMBER				
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30
Sydenham - -	..	..	..	..	..	..	..	..	..	..	87	90	80	82	88	88	87	88	78	88	96	..	84	85	..	84
Lewisham - -	78	86	65	68	83	79	74	74	72	74	81	85	77	74	85	86	85	82	88	92	90	85	85	87	90	89
Royal Observatory	78	85	72	72	90	82	71	72	72	73	80	81	77	84	89	87	80	84	88	88	90	85	85	86	90	88
Bexley Heath -	..	..	..	..	..	..	..	..	80	75	79	81	77	82	87	81	82	87	88	88	91	85	84	84	83	84
Brixton Road -	..	..	..	..	..	..	..	..	63	65	69	73	71	74	79	80	77	86	74	86	85	..	..	..	..	..
Camberwell - -	..	..	..	..	..	..	..	..	..	..	83	83	75	80	84	86	82	87	84	..	..	82	78	79	92	..
Dreadnought -	..	..	..	..	..	..	..	..	..	..	89	90	..	91	92	81	80	82	82	88	85	..	..	..	..	..
Millbank - -	..	..	..	..	..	..	..	..	..	..	..	74	74	76	80	90	82	81	83	85	85	78	80	81	83	78
Brompton - -	..	..	..	..	..	..	..	..	..	..	..	77	76	78	81	80	84	85	85	86	86	80	88	82	85	..
Board of Health -	..	..	..	..	..	..	..	..	..	66	73	76	77	79	78	80	86	83	84	92	97	80	76	80	81	82
St. Giles - -	..	..	..	..	..	..	..	..	..	..	..	80	80	87	90	94	95	77	91	..	..	..	..	..	..	..
St. Thomas' Hosp.	77	90	66	65	83	70	75	75	70	66	79	76	73	81	83	86	91	82	81	87	84	87	86	86	92	94
Poplar - - -	..	..	..	..	..	..	..	..	..	..	81	83	83	83	91	85	84	91	91	92	97	92	91	94	96	93
Guildhall - -	..	..	..	..	..	..	..	..	..	..	..	..	83	79	80	80	84	88	79	89	92	83	..	..	..	..
Somerset House -	..	..	..	..	..	..	..	..	..	..	79	71	75	83	74	67	82	78	80	87	84	76	75	79	84	81
Chiswell Street -	..	..	..	..	..	..	..	..	80	74	76	86	77	..	82	73	77	91	..	..	..	..	..	..	..	..
St. Mary's Hosp. -	76	80	91	67	87	74	75	75	72	70	80	83	81	75	88	80	82	80	82	83	86	83	80	77	87	86
Bethnal Green -	..	..	..	..	..	..	..	..	..	..	..	63	69	74	73	78	81	81	77	86	86	85	76	81	..	..
St. John's Wood -	72	84	73	70	91	78	75	75	77	69	83	..	..	..	..	..	..	..	..	86	88	84	84	84	85	88
St. Pancras - -	..	..	..	..	..	..	..	..	..	..	..	92	76	75	77	77	87	84	76	84	..	..	..	..	..	..
Highgate - -	..	..	..	..	..	..	..	..	..	..	83	79	70	79	81	90	83	86	87	91	93	87	88	87	..	91
Enfield Vicarage -	72	76	65	65	75	76	..	70	..	..	71	73	74	81	82	82	82	90	84	86	..	81	83	92	86	79
Means - -	75	84	72	68	85	76	74	73	73	72	80	80	76	80	83	82	83	84	83	88	88	83	83	84	87	86

It would seem therefore that the distribution of humidity has been very irregular, and few general results can be drawn from the foregoing numbers. Its distribution is generally under the influence of local circumstances, and has been in great measure influenced by the proximity of the River Thames. The most humid station, as might be expected, is the Dreadnought Hospital Ship, but the least humid is scarcely to be determined. Those of Highgate and Enfield might have been so considered had they not in some few weeks exceeded in humidity the mean of all others. The following Table contains the mean monthly humidity compared with the humidity of the year 1854:—

TABLE XXVI.—Showing the Monthly Difference of the Humidity of the Air from the Average, for the Year 1854.

Months.	Humidity of the Air (Complete Saturation = 1000.)		Excess in the Year 1854 above the Average.
	Average.	Mean in the Year 1854.	
January - -	885	917	+32
February - -	872	843	−29
March -	825	795	−30
April	802	775	−27
May - -	780	850	+70
June - -	758	825	+67
July - -	788	783	− 5
August - -	810	771	−39
September -	827	770	−57
October - -	862	846	−16
November -	885	916	+31
December -	889	872	−17

From the numbers in the last column, it seems that January, May, June, and November, were more humid than the average, and that the remaining months were less so than usual.

The following Table contains the weight of vapour in a cubic foot of air in every week, and the next Table the monthly values.

TABLE XXVII.—Weekly Mean Weight of Vapour in a Cubic Foot of Air.

Name of Station.	Week ending																									
	July				August				September					October				November				December				
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30
	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.
Sydenham - -	..	..	..	..	..	..	..	..	..	..	5·4	4·2	4·0	4·0	3·8	3·2	3·1	3·6	2·6	2·8	2·6	..	2·8	3·0	..	2·4
Lewisham - -	4·3	4·5	4·3	4·9	4·9	4·7	4·3	4·5	4·9	4·4	4·8	4·6	3·9	3·7	3·8	3·3	3·1	3·5	3·0	2·9	3·0	2·5	2·8	2·9	2·7	2·7
Royal Observatory	4·3	4·5	4·7	4·9	5·0	4·8	4·4	4·4	4·9	4·2	4·8	4·3	3·9	4·0	3·9	3·3	3·0	3·6	2·9	2·8	2·5	2·5	2·8	2·9	2·8	2·7
Bexley Heath -	..	..	..	..	..	..	..	..	5·2	4·1	4·6	4·5	3·9	4·1	3·9	3·1	3·0	3·6	2·9	2·9	2·5	2·8	2·8	2·9	2·7	2·5
Brixton Road -	..	..	..	..	..	..	..	..	5·1	4·0	4·6	3·9	3·9	3·8	3·7	2·9	2·9	3·7	2·6	2·9	2·4	..	..	..	..	..
Camberwell - -	..	..	..	..	..	..	..	..	..	..	5·0	4·5	3·7	4·0	3·9	3·3	3·1	3·7	2·9	..	..	2·8	2·6	2·7	2·7	..
Dreadnought -	..	..	..	..	..	..	..	..	..	..	5·4	5·3	..	4·7	4·4	3·5	3·3	3·9	3·2	3·2	2·8	..	..	..	..	..
Millbank - -	..	..	..	..	..	..	..	..	..	..	..	4·3	3·8	3·8	3·7	3·5	3·1	3·5	2·9	2·8	2·4	2·3	2·9	2·8	2·7	2·4
Brompton - -	..	..	..	..	..	..	..	..	..	..	..	4·2	3·7	3·9	3·6	3·1	3·0	3·5	2·9	2·8	2·5	2·4	2·9	2·9	2·9	..
Board of Health -	..	..	..	..	..	..	..	..	..	4·0	4·4	4·3	3·9	4·0	3·5	3·1	3·1	3·5	2·8	3·1	2·8	2·5	2·6	2·8	2·6	2·4
St. Thomas' Hosp.	4·2	4·7	4·6	4·8	4·8	4·7	4·4	4·8	4·7	4·9	4·8	4·3	3·8	3·9	3·8	3·3	3·4	3·6	2·8	2·9	2·4	2·6	3·0	2·9	3·0	2·9
Poplar - - -	..	..	..	..	..	..	..	..	..	..	5·2	4·8	4·1	4·1	4·1	3·2	3·1	3·7	3·1	3·0	2·8	2·7	3·0	3·3	3·0	2·9
Guildhall - -	..	..	..	..	..	..	..	..	..	..	..	..	4·0	4·2	3·8	3·2	3·1	3·8	2·8	3·1	2·6	2·6	..	..	..	..
Somerset House -	..	..	..	..	..	..	..	..	..	..	5·0	3·8	3·8	3·7	3·5	2·7	3·0	3·5	2·8	3·0	2·4	2·4	2·7	2·7	2·7	2·6
St. Giles - -	..	..	..	..	..	..	..	..	..	..	..	4·4	4·2	4·5	4·3	3·6	3·5	3·7	3·2	..	..	..	..	..	..	..
Chiswell Street -	..	..	..	..	..	..	..	..	6·2	4·9	4·9	4·9	4·3	..	4·0	3·1	3·1	4·0	..	..	..	..	..	..	..	..
St. Mary's Hosp. -	4·1	4·3	5·5	5·0	4·9	4·5	4·3	4·5	5·0	4·5	5·0	4·5	4·4	3·8	3·6	3·1	3·1	3·6	2·8	2·8	2·5	2·5	2·8	2·7	2·6	2·7
Bethnal Green -	..	..	..	..	..	..	..	..	..	..	..	3·6	3·6	3·8	3·4	3·1	3·0	3·6	2·6	2·8	2·4	2·6	2·6	3·0	..	..
St. John's Wood -	4·0	4·3	4·7	4·8	5·0	4·6	4·3	4·4	5·2	4·1	4·8	..	..	..	..	..	..	..	..	2·7	2·4	2·4	2·7	2·7	2·6	2·6
St. Pancras - -	..	..	..	..	..	..	..	..	..	..	..	4·5	3·5	3·6	3·4	3·0	3·2	3·6	2·7	2·9	..	..	..	..	..	..
Highgate - -	..	..	..	..	..	..	..	..	..	..	5·0	4·5	3·9	4·0	3·8	3·6	3·2	3·7	3·0	2·9	2·5	2·5	2·9	2·9	..	2·7
Enfield Vicarage -	4·0	4·0	4·0	4·4	4·3	4·0	..	4·2	..	..	3·6	4·1	3·4	3·8	3·4	3·0	3·0	3·3	2·7	1·6	..	2·3	2·6	2·9	2·5	2·3
Means - -	4·1	4·4	4·6	4·8	4·8	4·5	4·3	4·5	5·2	4·2	4·8	4·4	3·9	4·0	3·8	3·2	3·1	3·6	2·8	2·8	2·6	2·5	2·8	2·9	2·7	2·6

TABLE XXVIII.—SHOWING the MONTHLY DIFFERENCE from the AVERAGE of the WEIGHT of VAPOUR in a CUBIC FOOT of AIR.

MONTHS.	Weight of Vapour in a Cubic Foot of Air.		
	Mean.	In the Year 1854.	Excess in 1854.
	grs.	grs.	grs.
January - -	2·6	2·7	+ 0·1
February - -	2·6	2·6	0·0
March - -	2·7	2·8	+ 0·1
April - -	3·1	3·1	0·0
May - -	3·7	3·7	0·0
June - -	4·3	4·2	— 0·1
July - -	4·9	4·6	— 0·3
August - -	4·9	4·7	— 0·2
September -	4·4	4·3	— 0·1
October - -	3·7	3·6	— 0·1
November -	3·1	2·9	— 0·2
December -	2·8	2·8	0·0

From this Table it seems that from June to November there was $\frac{1}{20}$th less water in the air than the average for these months.

The next Table shows the mean monthly weight of a cubic foot of air under the mean temperature, humidity, and pressure.

TABLE XXIX.—SHOWING the MONTHLY DIFFERENCE from the AVERAGE of the WEIGHT of a CUBIC FOOT of AIR in the YEAR 1854.

MONTHS.	Mean Weight of a Cubic Foot of Air.		Excess in 1854 above the Mean.
	Average.	In the Year 1854.	
	grs.	grs.	grs.
January - -	549	546	— 3
February - -	549	554	+ 5
March - -	547	551	+ 4
April - -	540	542	+ 2
May - -	533	534	+ 1
June - -	526	529	+ 3
July - -	524	525	+ 1
August - -	524	526	+ 2
September -	530	532	+ 2
October - -	535	536	+ 1
November -	542	547	+ 5
December -	550	546	— 4

From this Table it seems that the atmosphere has been more than usually dense in every month excepting January and December.

Direction of the Wind.

The direction of the wind has been observed either by the motion of the clouds or by means of a vane. At some stations I was obliged to dispense with observations from the unfavourable position of the Observer for recording them with accuracy. At the Royal Observatory, Greenwich, the direction of the wind is recorded continually by means of Osler's and Whewell's self-registering anemometers, and the results are published weekly in the Report of the Registrar-General. The following Tables give the mean direction of the wind, as observed at the several stations during the periods of their continuance:—

TABLE XXX.—Showing the GENERAL DIRECTION of the WIND at the several STATIONS.

1854. — PERIOD OF CONTINUANCE.	GENERAL DIRECTION of the WIND.															
	Sydenham.	Lewisham.	Royal Observatory.	Bexley Heath.	Brixton Road.	Camberwell.	Millbank Prison.	Brompton.	Board of Health.	St. Thomas's Hospital.	Poplar.	St. Mary's Hospital.	Bethnal Green.	St. John's Wood.	St. Pancras.	Highgate.
July 1 to July 6	..	S.W.	S.W.	..	..	..	..	..	..	S.W.	..	S.W.	..	S.W.	..	..
„ 7 to „ 11	..	N.N.E.	N E.	..	..	..	..	..	..	S.E. & S.W.	..	E. & S.W.	..	N.E.	..	..
„ 12 to „ 22	..	W.S.W.	S.W.	..	..	..	..	..	..	W. & S.W.	..	W. & S.W.	..	S.W. & N.W.	..	..
„ 23 to „ 29	..	E.N.E.	N.E.	..	..	..	..	..	..	N.E.	..	N.E.	..	N.E.	..	..
„ 30 to Aug. 2	..	S.W.	S.W.	..	..	..	..	..	..	S.W.	..	S.W.	..	S.W.	..	..
Aug. 3 to „ 8	..	N.N.E.	N.	..	..	..	..	..	..	N.W.	..	N.N.E.	..	N.E.	..	..
„ 9 to „ 24	..	S.W.	S.W.	..	..	..	..	..	..	W.S.W.	..	W.	..	S.W.	..	..
„ 25 to Sept. 11	..	N.E.	N.E.	N.E.	N.E.	..	..	..	..	N.W. & N.E.	..	N.E.	..	N.E.	..	N.E.
Sept. 12 to „ 26	..	W.S.W.	W.S.W.	W.S.W.	W.S.W.	W.S.W.	W.	W.N.W.	S.W.	W.	W.S.W.	W.S.W.	W.	..	N.W.	S.W.
„ 27 to Oct. 2	E. & W.	E.S.E.	E.S.E.	S.E.	N.E	E.	S.E. & S.W.	S.E. & S.W.	S.E.	S.W & S.E.	E.	E.S.E.	S.E. & S.W.	..	S.E.	E. & N.W.
Oct. 3 to „ 6	W.	S.W.	S.W.	S.W.	S.W.	W.S.W.	S.W.	W.	S.W.	S.W.	W.	W.	W.	..	W.	S.W.
„ 7 to „ 10	S.E. & N.E.	E.N.E.	E.N.E. & W.S.W	E.N.E.	N.W.	E.N.E.	E.N.E.	W.S.W.	N.W. & S.W.	E.S.E. & W.	E.N.E.	E. & W.	N.E. & S.E.	..	N.E. & W.	N.E.
„ 11 to Nov. 12	W.	S.S.W.	S.W.	W.	W.N.W.	W.	N.W. & S.W.	N.W. & W.	W.	S.W. & N.W.	S.W. & N.W.	S.W. & N.W.	S.W. & W.	..	N.W. & S.W.	N.W. & S.W.
Nov. 13 to „ 16	S.E.	S.E.	S.E.	S.E.	S.E.	..	S.E.	S.	S.S.E.	S.E.	S.E.	S.E.	S.	S.E.	..	S.E.
„ 17 to „ 20	N.E.	N.E.	N.E.	N.N.E.	N.E.	..	N.E.	E.S.E.	N.E.	N.E.	N.N.E.	E.N.E.	N.N.E.	N.E.	..	N.E.
„ 21 to „ 23	S.E. & W.	S.W.	S.W.	S.W.	..	..	S.W.	N.N.W.	S.W.	var.	S.W.	W.N.W.	W.N.W.	S.W.	..	..
„ 24 to „ 26	N.N.W.	N.	N.	N.	..	..	N.	N.N.E.	N.N.E.	N.	N.E.	N.N.E.	N.	N.N.E.	..	N.N.W.
„ 27 to Dec. 31	W.S.W.	W.S.W.	W.S.W.	W.S.W.	..	..	W.S.W.	N.W.	S.W.	W.S.W.	W.S.W.	W.S.W.	W.S.W.	W. & S.W.	..	S.W.

These results show that the direction of the wind, as determined at the several stations, are in close accordance with each other.

From them we see that the direction of the wind from July 1 to September 11 was alternately S.W. and N.E.; and out of the 73 days within this interval, the direction is S.W. on 37 days, and N.E. or N.N.E. on 36 days. Its force, however, was much smaller when from the N.E. than from the S.W; but of this I shall treat presently. From September 12 to 26 the general direction was W.S.W.; for 5 days it was mostly S.E.; for 4 days W.S.W.; then light and variable from October 7 to October 10, both days inclusive; and from October 11 it was W., and remained a compound of west till the end of the year.

The following Table shows the number of times out of 100 in which the wind blew at the several stations from each of the eight points of the compass till the end of October. The winds from intermediate points were equally divided between the two adjacent points:—

TABLE XXXI.—Showing the Frequency of the Several Winds.

Name of Station.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
Sydenham - - -	..	11	5	18	..	9	47	10
Lewisham - - -	8	15	4	10	8	33	10	12
Royal Observatory - -	9	15	4	9	7	34	9	13
Bexley Heath - - -	5	13	15	4	10	23	25	5
Brixton Road - - -	5	15	3	4	8	33	3	28
Camberwell - - -	8	6	9	6	2	20	26	23
Battersea - - - -	6	4	4	6	..	18	20	42
Millbank Prison - -	2	5	..	7	7	38	18	33
Brompton - - -	6	2	2	4	2	16	12	42
Board of Health - -	12	9	7	5	2	38	10	14
St. Thomas's Hospital -	6	8	13	6	4	20	16	27
Poplar - - - -	4	13	13	1	1	25	22	21
Chiswell Street - -	14	11	3	10	5	29	6	22
St. Mary's Hospital - -	3	9	11	13	3	22	12	27
Bethnal Green - - -	9	6	4	4	2	28	23	24
St. Pancras - - -	13	11	..	6	..	30	9	31
Highgate - - - -	12	6	1	4	32	10	27	8
Means - - -	8	9	7	7	7	25	17	26

We learn from these numbers that, in the period from August 25 till October 31, the wind blew nearly three times more frequently from between S.W. and N.W. than from the other points of the compass, which were about equal in amount.

On comparing the numbers in the Table, with those in the lower line, denoting the frequency of each wind for the whole district, it will be seen that southerly winds were in excess at Highgate, and north-westerly in defect. I have but little doubt of the accuracy of these observations, having confidence in the Observer and in the geographical position of the station to afford truthful results. Some insight is, therefore, afforded into the inclined currents on the opposite sides of the Metropolis.

At Bexley Heath there is a slight deficiency of N.W. It is like Highgate, an elevated and open district, and the directions are well determined. At Battersea and Brompton there is an excess of the N.W. but both stations are low, and it is likely that the numbers may have been over estimated.

Force of the Wind.

It is difficult to obtain accurate results of this element without adequate instrumental means, which, unfortunately, are very limited. The only small available instrument for this purpose with which I am acquainted is Lind's anemometer, but experience with this instrument has led me to place less value in its indications than in those in which the force of the wind is estimated.

From the observations taken at the Royal Observatory, Greenwich, it is found that the square of the numbers in a scale of nine degrees of estimated wind force corresponds to the pounds pressure on a square foot of surface. The nine degrees of wind force, thus estimated, are as follows:—

A gentle breeze - - - - -	0·3
A light breeze, the air being in sensible motion -	0·5
A brisk or moderate breeze - - - -	0·7
A strong breeze - - - - -	1·0
A hard wind - - - - -	2·0
A moderate gale - - - - -	3·0
A strong gale - - - - -	4·0
A heavy gale - - - - -	5·0
A great storm - - - - -	6·0

The strength or force of the wind is thus estimated and converted into numbers. The following Table shows the weekly results:—

Table XXXII.—Showing the Mean Estimated Force of the Wind at the Several Stations.

1854. — Period of Continuance.	General Force of the Wind.												
	Sydenham.	Lewisham.	Bexley Heath.	Brixton Road.	Camberwell.	Millbank Prison.	Board of Health.	St. Thomas's Hospital.	Poplar.	St. Mary's Hospital.	St. John's Wood.	St. Pancras.	Highgate.
July 1 to July 6 - -	..	1·4	..	..	..	..	..	..	..	..	1·7	..	..
„ 7 to „ 11 - -	..	0·3	..	..	..	..	..	..	..	..	1·0	..	..
„ 12 to „ 22 - -	..	1·4	..	..	..	..	..	..	..	..	1·2	..	..
„ 23 to „ 29 - -	..	0·6	..	..	..	..	..	..	..	..	1·6	..	..
„ 30 to Aug. 2 - -	..	1·7	..	..	..	..	..	..	..	..	1·3	..	..
Aug. 3 to „ 8 - -	..	1·0	..	..	..	..	..	..	..	..	1·4	..	..
„ 9 to „ 24 - -	..	1·4	..	..	..	..	..	..	..	..	1·8	..	..
„ 25 to Sept. 11 - -	..	0·3	1·4	..	..	..	..	..	..	..	0·2	..	0·4
Sept. 12 to „ 26 - -	0·8	1·8	1·8	0·4	0·9	0·4	0·8	0·8	0·5	0·5	..	1·3	0·5
„ 27 to Oct. 2 - -	0·4	0·4	0·5	0·5	0·2	0·3	0·4	0·4	0·4	0·5	..	1·0	0·5
Oct. 3 to „ 6 - -	0·8	1·8	1·6	0·8	0·4	0·3	0·6	0·5	0·5	0·6	..	1·7	0·4
„ 7 to „ 10 - -	0·7	1·2	1·0	0·7	0·4	0·3	0·6	0·7	0·5	0·3	..	1·0	0·3
„ 11 to Nov. 12 - -	0·6	1·0	1·7	0·6	0·5	0·4	0·5	0·5	0·4	0·4	..	1·7	0·4
Nov. 13 to „ 16 - -	0·5	0·5	0·5	0·3	..	0·3	0·7	0·3	0·3	0·6	1·2	..	0·6
„ 17 to „ 20 - -	0·7	1·1	2·5	0·6	..	0·6	0·8	0·7	0·4	0·6	2·8	..	0·5
„ 21 to „ 23 - -	0·6	0·5	2·0	0·5	..	0·3	0·4	0·4	0·3	0·6	1·5	..	0·5
„ 24 to „ 26 - -	0·7	0·5	0·5	..	..	0·4	0·5	0·3	0·2	0·6	1·5	..	0·4
Nov. 27 to Dec. 31 - -	..	0·5	2·0	..	..	0·7	0·7	0·5	0·4	0·6	1·8	..	0·5

We learn from this Table that the differences between the estimated forces of the wind at the extreme south and north stations are small, but that at the intermediate and low stations the estimated force has at all times been much less. It is not, however, to be expected that these results are strictly accurate, from irregularities due to local causes and the unavoidable errors of observation. In order to lessen their influence, the results from Sydenham, Lewisham, Bexley, St. Pancras, and Highgate have been combined in one group, and the results from the remaining stations in another group. The former would show the mean force of the wind at the outlying stations, and the latter at the central stations. These numbers were then converted into pounds pressure on a square foot of surface by the following Table:—

0·25 by estimation, corresponds to	1 oz.	pressure on a square foot.
0·50 „ „	4 oz.	„ „
0·75 „ „	9 ozs.	„ „
1·00 „ „	1 lb.	„ „
1·5 „ „	$2\frac{1}{4}$ lbs.	„ „
2·0 „ „	4 lbs.	„ „

In this way the next Table was formed.

TABLE XXXIII.—Showing the Mean Force of the Wind by Estimation, and in lbs. Pressure on a Square Foot of Surface, at the Boundary and Central Stations.

1854. — Period.	Mean Force of the Wind: Estimated: Northern and Southern Stations.	Estimated: Central Stations.	In pounds pressure on a square foot of surface: Northern and Southern Stations. lbs. oz.	In pounds pressure: Central Stations. lbs. oz.	General Direction of the Wind.
July 1 to July 6 - -	1·5	..	2 4	..	S.W.
July 7 to July 11 -	0·7	..	0 8	..	N.N.E.
July 12 to July 22 -	1·3	..	1 8	..	W.S.W
July 23 to July 29 -	1·1	..	1 3	..	N.E.
July 30 to August 2 -	1·5	..	2 4	..	S.W.
August 3 to August 8 -	1·2	..	1 7	..	N.N.E.
August 9 to August 24	1·6	..	2 6	..	S.W.
August 25 to Sept. 11 -	0·8	..	0 10	..	N.E.
Sept. 12 to Sept. 26 -	1·2	0·5	1 7	0 4	W.S.W.
Sept. 27 to October 2 -	0·5	0·3	0 4	0 $1\frac{1}{2}$	E.S.E.
October 3 to October 6	1·2	0·5	1 7	0 4	S.W.
October 7 to October 10	0·8	0·4	0 10	0 $2\frac{1}{2}$	E.N.E.
October 11 to Nov. 12 -	1·1	0·4	1 3	0 $2\frac{1}{2}$	S.W.
Nov. 13 to Nov. 16 -	0·6	0·5	0 6	0 4	S.E.
Nov. 17 to Nov. 20 -	1·5	0·6	2 4	0 6	N.E.
Nov. 21 to Nov. 23 -	1·0	0·5	1 0	0 4	S.W.
Nov. 24 to Nov. 26 -	0·7	0·4	0 8	0 $2\frac{1}{2}$	N.
Nov. 27 to Dec. 31 -	0·9	0·6	0 13	0 6	W.S.W.

From these results it would appear that the force of the wind has been very much less at the stations of low elevation than over the high and outlying stations. The ratio of estimated force is as $2\frac{1}{2}$ to 1. The difference of force is, however, more clearly shown in the numbers *in the third and fourth* columns, showing the simultaneous pressure

on a square foot of surface at the two groups of stations. From these it appears that during the windy period following the almost calm weather ending September 11, whilst the average pressure at the boundary stations was 1 lb. 7 ozs., it was only $\frac{1}{4}$ lb. on the same surface at those situated in the heart of London; and similar differences of pressure are shown in the other numbers of this Table. The small pressure thus found to exist at the central stations implies that for the greater number of hours in the night the air must have been in an absolutely calm state, and that in the periods from August 25 to September 11, September 27 to October 2, and from October 7 to November 12, there was an upper but no under current of air.

It is now necessary to compare the velocity of the air in its daily motion during the period under investigation with the average velocity for the same period of the year, as determined from a series of observations.

Velocity of the Air.

The horizontal movement of the air was determined daily by the use of Whewell's anemometer, at the Royal Observatory Greenwich. It has been in use since the year 1845, from which time the daily movement of the air has been ascertained. The following Table shows the average movement of the air, as found from the observations of the years from 1845 to 1853 inclusive.

TABLE XXXIV.—Showing the Average Daily Horizontal Movement of the Air.

Day of Month.	July.	August.	September.	October.	November.	December.
	miles.	miles.	miles.	miles.	miles.	miles.
1	168	67	109	105	108	141
2	121	85	102	98	111	144
3	134	86	81	110	98	116
4	71	102	79	143	117	159
5	98	96	82	122	159	156
6	115	107	71	128	142	167
7	110	106	66	158	171	147
8	107	116	77	134	116	138
9	125	135	86	151	103	138
10	104	101	86	124	107	158
11	76	141	67	92	128	127
12	77	83	100	103	94	109
13	78	103	77	101	83	110
14	109	92	52	108	86	161
15	87	108	86	90	106	183
16	98	93	104	67	152	183
17	98	97	93	134	167	136
18	120	128	95	143	146	133
19	121	140	93	117	152	146
20	118	132	97	124	169	133
21	127	117	119	146	112	109
22	106	74	94	150	157	107
23	94	84	80	146	145	71
24	83	86	66	126	137	71
25	121	123	97	103	163	106
26	111	161	122	89	117	171
27	114	131	115	118	102	101
28	81	98	91	96	131	82
29	89	89	121	84	128	108
30	93	84	123	99	137	106
31	110	81		88		95
Means -	105	105	91	116	128	129

TABLE XXXV.—Showing the Horizontal Movement of the Air.

Days of the Month.		Horizontal Movement of the Air in Miles.								The whole or part of the day calm.
		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	
		miles.	miles.	miles.	miles.	miles.	miles.	miles.	miles.	
July	1	..	..	..	..	15	..	..	..	calm.
	2	..	..	..	..	40.	..	..	..	calm.
	3	..	..	..	..	..	95	..	..	calm.
	4	..	..	..	..	..	42	43	..	—
	5	..	..	..	..	72	..	73	..	—
	6	..	..	..	..	..	45	..	..	—
	7	..	..	..	light.	..	..	..	..	calm.
	8	..	..	..	..	..	..	..	..	calm.
	9	..	..	..	..	..	..	..	..	calm.
	10	..	45	..	..	..	..	..	..	—
	11	30	30	..	..	..	..	..	..	calm.
	12	..	..	..	..	..	..	35	35	—
	13	..	..	..	..	..	..	80	..	calm.
	14	..	..	..	..	..	135	..	..	
	15	..	..	.	..	..	45	..	45	calm.
	16	..	..	..	..	..	..	90	..	—
	17	..	..	..	..	30	30	..	..	calm.
	18	..	..	..	..	..	53	52	..	—
	19	..	..	..	..	70	70	..	..	—
	20	..	95	..	..	..	..	..	..	—
	21	..	..	..	..	..	35	..	..	calm.
	22	..	..	..	..	..	65	..	..	calm.
	23	..	..	..	..	..	35	..	..	calm.
	24	..	..	80	..	..	..	..	..	—
	25	..	41	41	..	..	..	..	..	—
	26	..	25	..	..	..	..	..	..	calm.
	27	..	95	..	..	..	..	..	..	—
	28	..	85	..	..	..	..	..	..	—
	29	..	..	25	25	..	..	..	..	calm.
	30	..	..	..	..	..	120	..	..	—
	31	..	..	..	..	..	115	..	..	—
Sums	-	30	416	146	25	227	885	373	80	Daily average, 69 miles.
August	1	..	..	..	..	..	60	..	..	—
	2	..	..	..	..	..	55	..	55	—
	3	..	80	..	..	..	..	..	..	calm.
	4	83	..	..	..	..	..	..	82	—
	5	50	..	..	..	..	..	..	50	—
	6	37	..	..	..	..	..	..	38	calm.
	7	10	..	..	..	..	..	..	..	calm.
	8	..	25	..	..	..	25	..	..	calm.
	9	..	..	..	..	..	40	..	..	calm.
	10	..	..	..	..	..	..	..	75	calm.
	11	..	..	..	..	..	130	..	..	—
	12	..	..	..	..	57	57	..	..	—
	13	..	..	..	18	17	..	..	..	calm.
	14	..	..	..	..	..	90	..	..	calm.
	15	..	..	..	..	..	50	..	..	calm.
	16	..	..	..	..	..	60	..	..	calm.
	17	..	..	..	..	..	..	30	..	calm.
	18	..	..	..	..	..	30	30	..	calm.
	19	..	..	..	..	..	125	..	..	—
	20	..	..	..	..	28	29	29	..	—
	21	..	..	..	..	..	115	..	..	—
	22	..	..	..	..	..	70	70	..	—
	23	..	..	..	..	..	190	..	..	—
	24	..	..	..	..	..	102	103	..	—

Table XXXV.—Showing the Horizontal Movement of the Air—*cont.*

Days of the Month.	Horizontal Movement of the Air in Miles.								
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	The whole or part of the day calm.
	miles.	miles.	miles.	miles.	miles.	miles.	miles.	miles.	
August 25	20	. .	. .	. .	. .	. .	20	. .	calm.
26	20	. .	. .	. .	. .	20	. .	20	calm.
27	25	. .	. .	. .	. .	. .	. .	. .	calm.
28	40	. .	. .	. .	. .	. .	. .	. .	calm.
29	10	. .	. .	. .	. .	. .	. .	. .	calm.
30	. .	. .	. .	. .	. .	50	. .	. .	calm.
31	. .	17	. .	. .	. .	18	. .	. .	calm.
Sums -	295	122	. .	18	102	1316	252	320	Daily average, 78 miles.
September 1	40	. .	. .	. .	. .	. .	. .	. .	calm.
2	. .	. .	23	22	. .	. .	. .	. .	calm.
3	. .	22	. .	23	. .	. .	. .	. .	calm.
4	. .	60	. .	. .	. .	. .	. .	. .	calm.
5	. .	35	. .	. .	. .	. .	. .	. .	calm.
6	. .	8	. .	. .	7	. .	. .	. .	calm.
7	. .	10	. .	. .	. .	. .	. .	. .	calm.
8	. .	25	. .	. .	. .	. .	. .	. .	calm.
9	. .	5	. .	. .	. .	. .	. .	. .	calm.
10	. .	. .	. .	. .	. .	. .	. .	. .	calm.
11	. .	15	. .	. .	. .	. .	. .	. .	calm.
12	. .	.	. .	70	. .	70	. .	. .	—
13	. .	.	. .	. .	. .	150	. .	. .	—
14	. .		. .	. .	. .	65	65	. .	—
15	. .	.	. .	. .	. .	155	. .	. .	—
16	. .	. .	. .	. .	. .	80	80	. .	—
17	. .	. .	. .	. .	. .	170	. .	. .	—
18	. .	. .	. .	. .	. .	235	. .	. .	—
19	. .	. .	. .	. .	. .	180	. .	. .	—
20	60	. .	. .	. .	. .	60	. .	. .	—
21	. .	. .	. .	. .	. .	. .	73	72	—
22	. .	. .	. .	. .	. .	40	40	40	—
23	. .	. .	. .	. .	. .	47	. .	48	—
24	. .	. .	. .	. .	. .	. .	150	. .	—
25	. .	. .	. .	. .	. .	. .	17	18	calm.
26	. .	. .	. .	. .	. .	. .	. .	. .	calm.
27	. .	. .	17	18	. .	. .	. .	. .	calm.
28	. .	. .	. .	. .	. .	. .	. .	. .	calm.
29	. .	. .	. .	. .	. .	. .	. .	. .	calm.
30	. .	. .	. .	. .	. .	. .	. .	. .	calm.
Sums -	100	180	40	133	7	1252	425	178	Average per day, 77 miles.
October 1	. .	. .	. .	. .	. .	. .	. .	. .	calm.
2	. .	. .	. .	. .	. .	. .	. .	. .	calm.
3	. .	. .	. .	. .	. .	45	. .	45	—
4	. .	. .	. .	. .	. .	175	. .	. .	—
5	. .	. .	. .	. .	. .	165	. .	. .	—
6	. .	50	. .	. .	. .	50	. .	. .	calm.
7	. .	180	. .	. .	. .	. .	. .	. .	—
8	. .	. .	60	. .	. .	. .	. .	. .	—
9	. .	. .	40	. .	. .	. .	40	. .	—
10	. .	. .	. .	. .	. .	46	47	47	—
11	62	. .	. .	. .	. .	63	. .	. .	—

TABLE XXXV.—Showing the Horizontal Movement of the Air—*cont.*

Days of the Month.	Horizontal Movement of the Air in Miles.								
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	The whole or part of the day calm.
	miles.	miles.	miles.	miles.	miles.	miles.	miles.	miles.	
October 12	45	..	..	..	..	..	..	..	—
13	..	..	..	..	..	..	..	..	calm.
14	..	..	..	..	..	..	..	..	calm.
15	..	..	..	..	..	..	..	..	calm.
16	15	..	..	..	..	..	..	..	calm.
17	..	150	..	..	..	..	..	..	—
18	..	..	..	..	..	..	..	160	—
19	..	..	..	..	..	78	..	77	—
20	..	..	..	..	..	55	55	..	—
21	..	..	..	..	..	77	..	78	—
22	..	..	..	..	..	53	..	52	—
23	..	..	..	..	..	55	..	55	—
24	..	20	..	..	..	20	..	..	calm.
25	..	90	..	..	..	..	..	..	calm.
26	..	..	..	..	..	10	..	..	calm.
27	..	..	..	..	30	30	..	..	calm.
28	..	..	..	55	..	..	..	..	calm.
29	..	..	..	16	17	17	..	..	calm.
30	..	..	..	70	..	..	..	..	—
31	..	..	..	25	..	25	..	..	calm.
Sums -	122	490	100	166	47	964	142	514	Average per day, 82 miles.
November 1	..	..	..	..	7	8	..	..	calm.
2	..	..	..	52	53	..	..	..	—
3	..	..	..	..	..	38	38	39	—
4	..	..	..	..	..	140	..	..	calm.
5	..	..	..	..	..	25	25	25	—
6	30	..	..	..	..	..	30	..	—
7	..	..	..	..	..	90	..	..	—
8	..	..	..	..	..	125	..	..	—
9	52	..	..	..	..	..	..	53	—
10	..	..	..	..	..	145	..	..	—
11	26	..	..	..	..	27	..	27	—
12	25	..	..	..	..	..	..	..	—
13	..	..	..	75	75	..	..	..	—
14	..	..	..	95	..	..	..	..	calm.
15	..	..	..	32	..	31	..	..	—
16	..	..	..	15	..	..	..	..	—
17	62	63	..	..	..	..	..	..	—
18	..	163	..	..	..	..	..	..	—
19	..	135	..	..	..	..	..	..	—
20	..	65	..	..	..	..	..	..	—
21	..	..	..	..	..	150	..	..	—
22	..	..	..	..	..	30	30	..	—
23	..	18	..	..	..	18	..	..	—
24	100	..	..	..	..	..	..	..	—
25	115	..	..	..	..	..	..	..	—
26	10	..	..	..	..	..	..	..	—
27	..	..	..	..	..	85	..	..	—
28	..	..	..	..	..	255	..	..	—
29	..	..	..	..	..	135	..	..	—
30	..	..	..	..	..	155	..	..	—
Sums -	420	446	..	269	135	1457	123	134	Average per day, 86 miles.

TABLE XXXV.—Showing the Horizontal Movement of the Air—*cont.*

Days of the Month.	Horizontal Movement of the Air in Miles.								
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	The whole or part of the day calm.
	miles.	miles.	miles.	miles.	miles.	miles.	miles.	miles.	
December 1	..	..	..	..	..	..	185	..	—
2	..	..	..	..	..	80	80	..	—
3	..	..	..	..	..	137	138	..	—
4	..	..	..	..	..	145	145	..	—
5	..	..	..	..	..	245	..	..	—
6	..	..	..	..	..	83	82	..	—
7	62	..	..	..	..	..	63	..	—
8	..	..	..	..	..	165	..	..	—
9	..	..	..	..	..	..	113	112	—
10	48	47	..	..	..	..	..	..	—
11	..	..	..	..	..	160	..	..	—
12	..	..	..	..	..	75	75	..	—
13	..	..	..	..	..	265	..	..	—
14	..	..	..	..	..	290	..	..	—
15	..	..	..	..	..	163	162	..	—
16	..	..	..	..	..	83	..	82	—
17	..	..	..	..	..	78	77	..	—
18	122	..	..	..	..	123	..	..	—
19	35	..	..	..	..	35	..	35	—
20	70	..	..	..	..	..	..	70	—
21	..	..	..	..	..	105	105	..	—
22	..	..	..	..	..	125	125	..	—
23	..	..	..	..	..	40	..	40	—
24	..	..	..	..	..	..	230	..	—
25	..	..	..	..	..	110	110	..	—
26	..	..	..	..	..	113	112	..	—
27	..	..	..	..	..	..	80	..	—
28	22	..	..	..	..	..	23	..	—
29	..	..	..	..	..	52	53	..	—
30	..	..	..	..	..	42	43	..	—
31	..	..	..	..	..	..	300	..	—
Sums -	359	47	..	..	..	2714	2301	339	Average per day, 186 miles.

The directions of the wind from day to day are shown in these Tables, as well as the horizontal movement of the air in miles. The figures in the lower lines show the number of miles the air has moved in each direction, referred to eight points of the Azimuthal Circle, and the average number of miles daily, independently of direction. By comparing the latter with those in the lower lines of Table XXXIV., it will be seen that in July, the daily motion of the air was less than its average by 36 miles; in August by 27; in September by 14; in October by 34; in November by 42. In December its velocity was greater by 57 miles daily. In July a calm was noted on 16 days; in August on 19 days; in September on 17 days; in October on 13 days; in November on 3 days, and none in December. Thus, out of the 123 days, from July 1 to October 31, a calm was noted on 65 days, or one half of the whole number. The exceptions to this oppressive state were, on July 3, 6, 19, and 26; August 12, 14, 15, 23, 24; September 12 to September 24,

October 5, 7, 8, 11, 17, 18, 19, 20, 23, 24, and 28. In July the greatest pressure on the surface of a square foot was 2 lbs. in one instance; in August of 5 lbs. on the 24th; in September of 7 lbs. on the 24th; and in October of 10 lbs. on the 18th.

In each month the sum of the velocities is the greatest with the S.W. wind; the next in order, in July, was N.E.; in August N.W.; in September and October W.; in November N.N.E.; and in December N.N.W.

By resolving the sum of the horizontal movements of the air for each of the compound directions of the wind into two component forces, by multiplying each force by the cosine of the angle which its direction makes with the cardinal, the following results are obtained:—

1854. — MONTHS.	Direction of the Wind.			
	N.	E.	S.	W.
July - -	376	448	871	1,121
August -	627	99	1,032	1,457
September -	358	274	994	1,437
October -	831	564	846	1,187
November -	830	505	1,355	1,248
December -	552	31	1,919	4,460

From these numbers it appears that in—

July	the S. horizontal movement exceeded the N. by	495 Miles;	and the W. exceeded the E. by	673 Miles.
Aug.	„	405 „	„	1,358 „
Sept.	„	636 „	„	1,163 „
Oct.	„	15 „	„	623 „
Nov.	„	525 „	„	743 „
Dec.	„	1,367 „	„	4,129 „

By taking the means of the numbers in Table XXXV. corresponding to the period during the continuance of each wind, and also those observed within the same periods, the next Table is formed, showing the relative horizontal movement of the air, as compared with its mean value.

TABLE XXXVI.—Showing the COMPARISON of the AVERAGE with the daily observed HORIZONTAL MOVEMENT of the AIR.

1854. — Period of Continuance.	General Direction of Wind.	Daily Horizontal Movement of the Air.	
		Observed.	Daily Difference from Average.
		miles.	miles.
July 1 to July 6 - -	S.W.	71	— 47
„ 7 „ 11 - -	N.N.E.	35	— 83
„ 12 „ 23 - -	W.S.W.	88	— 16
„ 24 „ 29 - -	N.E.	65	— 34
„ 30 to Aug. 2 - -	S.W.	101	+ 12
Aug. 3 „ 8 - -	N.N.E.	80	— 22
„ 9 „ 24 - -	S.W.	96	— 11
„ 25 to Sept. 11 - -	N.E.	31	— 62
Sept. 12 „ 26 - -	W.S.W.	132	+ 40
„ 27 - - -	E.S.E.	35	— 80
„ 28 to Oct. 2 - -	Calm.	0	—136
Oct. 3 „ 6 - -	S.W.	132	+ 7
„ 7 „ 10 - -	E.N.E.	115	— 27
„ 11 to Nov. 12 - -	S.W.	83	— 31
Nov. 13 „ 16 - -	S.E.	81	— 26
„ 17 „ 20 - -	N.E.	122	— 37
„ 21 „ 23 - -	S.W.	82	— 56
„ 24 „ 26 - -	N.	75	— 64
„ 27 to Dec. 31 - -	W.S.W.	154	+ 26

The sign — denotes below the average, and + above the average.

From the numbers in this Table it will be seen that the velocity of the air has been much less than usual. From July 1 to September 11, with the exception of the four days between July 30 and August 2, it was moving with a diminished rate, and at times its velocity was very small, particularly in the period from August 25 to September 11, when its velocity was one-third only of its average; and in that of September 27 to October 2, when its velocity was only one-fourth part of its average for those days. These periods were the calmest within the series, and it is found in the preceding section that, although there was a slight upper current at high places, there was none at low; at the latter there was a dead calm, and the air was stagnant.

Electricity.

Till the end of September instruments for the observation of atmospheric electricity could not be obtained. At this time delicate and sensitive electrometers, made by Watkins and Hill, were supplied to six stations. Unfortunately one of them became deranged, and was not again in order till the end of November. The following Tables give the results for every day.

TABLE XXXVII.—Showing the Electricity of the Atmosphere at the several Stations.

Month and Day.		Lewisham.	Millbank.	Board of Health, Whitehall.	St. Thomas's Hospital.	Poplar.	St. Mary's Hospital.	Highgate.
September	1	var. P.	—	—	—	—	—	—
	2	var. P.	—	—	—	—	—	—
	3	mod. P.	—	—	—	—	—	—
	4	mod. P.	—	—	—	—	—	—
	5	mod. P.	—	—	—	—	—	—
	6	mod. P.	—	—	—	—	—	—
	7	mod. P.	—	—	—	—	—	—
	8	mod. P.	—	—	—	—	—	—
	9	mod. P.	—	—	—	—	—	—
	10	mod. P.	—	—	—	—	—	—
	11	mod. P.	—	—	—	—	—	—
	12	slight P.	—	—	—	—	—	—
	13	0	—	—	—	—	—	—
	14	0	—	—	—	—	—	—
	15	mod. P.	—	—	—	—	—	—
	16	mod. P.	—	—	—	—	—	—
	17	var. P.	—	—	—	—	—	—
	18	mod. P.	—	—	—	—	—	—
	19	0	—	—	—	—	—	—
	20	mod. P.	—	—	—	—	—	—
	21	var. P.	—	—	—	—	—	—
	22	mod. P.	—	—	—	—	—	—
	23	slight P.	—	—	—	—	—	—
	24	var. P.	—	—	—	—	—	—
	25	mod. P.	—	—	—	—	—	—
	26	var. P.	—	—	—	—	—	—
	27	mod. P.	—	—	—	—	—	—
	28	var. P.	—	0·1 N.	—	—	—	P.
	29	var. P.	—	0·2 P.	—	—	—	P.
	30	str. P.	—	0·1 P.	—	—	—	P.
October	1	var. P.	—	—	—	—	0	P.
	2	str. P.	—	0·25 P.	1·0 P.	—	0·5 P.	P.
	3	var. P.	—	0·05 N. 0·2 P.	0·5 P.	—	0	P.
	4	mod. P.	—	0·1 N.	0·7 P.	—	0	P.
	5	weak P.	—	0·05 N. 0·2 P.	0	—	0	P.
	6	str. P.N.	—	0·05 N. 0·2 P.	0	—	0.1 N.	P.
	7	str. P.	—	0·05 P.	1·4 P.	—	0	P.
	8	mod. P.	—	—	0	—	0·25 P.	P.
	9	str. P.	—	0·1 P.	0·4 P.	—	0	str. P.
	10	str. P.	—	0·2 P.	0·5 P.	—	0	P.
	11	var. P.	—	0·15 P.	0·9 P.	—	0	P.
	12	str. P.	—	0·1 P.	1·5 P.	—	0	N.
	13	str. P.	—	0·1 P.	1·2 P.	—	1·0 P.	P.
	14	str. P.	—	0	0·6 P.	—	0	N.
	15	weak P.	—	—	0	—	0	feeble N.
	16	mod. P.	—	0·75 P.	0·2 P.	—	0	N.
	17	mod. N.	—	0·05 P.	1·0 P.	—	0	N.
	18	mod. P.	—	—	0·2 P.	—	slight N.	N.
	19	str. P.	—	0·2 P.	0·7 N.	—	0	..
	20	weak P.	—	0·15 P.	0·2 P.	—	slight N.	P.
	21	str. P.	—	0·1 P.	1·7 P.	—	slight P.	P.
	22	0	—	—	0·3 P.	—	slight P.	0
	23	mod. P.	—	0·1 P.	1·3 P.	—	1·0 P.	P.
	24	str. P.N.	—	0·1 P.	1·0 P.	—	1·0 P.	P.
	25	str. N.	—	—	0	—	0	P.
	26	mod. N.P.	str. P.	0·2 P.	0·1 P.	—	0·5 P.	P.
	27	var. P.	mod. N.	0·17 P.	0·2 P.	—	1·5 P.	P.
	28	str. P.	mod. N.	0·05 P.	1·1 P.	—	0	var. P.
	29	str. P.	mod. P.N.	—	0·4 P.	—	0	P.
	30	mod. P.	mod. N.P.	0·07 P.	0·9 P.	—	0	P.
	31	str. P.	mod. P.	0·1 P.	1·4 P.	—	0	P.

Table XXXVII.—Showing the Electricity of the Atmosphere at the several Stations—*cont.*

Month and Day.	Lewisham.	Millbank.	Board of Health, Whitehall.	St. Thomas's Hospital.	Poplar.	St. Mary's Hospital.	Highgate.
November 1	str. P.	mod. P.	0·15 P.	0	—	0	P.
2	weak. P.	mod. P.	0·07 P.	0	—	0	P.
3	var. P.	mod. P.	0	1·0 P.	—	0	P.
4	str. P.	mod. P. str. N.	0·02 P.	0·2 N.	—	0	0
5	var. P.	str. P.	—	0·5 P.	—	0·5 P.	0
6	mod. P.	str. P.	0·10 P.	1·1 P.	—	0	0
7	str. P.	mod. P.	0·10 P.	0·9 P.	—	str. P.	P.
8	str. P.	str. P.	0·10 P.	0·1 P.	—	0	0
9	str. N.P.	mod. P.	0·07 P.	0·7 P.	—	0·25 P.	0
10	weak P.	gen. N. mod. P.	0·05 P.	0·7 P.	—	0	0
11	0	mod. P. str. N.	0·05 P.	0·8 P.	—	0	0
12	0	mod. P.N.	—	0·7 P.	—	0	0
13	mod. P.	mod. P.	0·05 P.	0	—	0	P.
14	str. N.P.	mod. P. str. N.	0·05 N.	0·2 P.	—	0	0
15	str. N.P.	mod. N.P.	0·05 N. 1·5 P.	0	—	v. str. P.	N.
16	str. N.P.	str. P.	0·22 P.	0	—	v. str. P.	P.
17	str. N.P.	str. P.	0·06 P.	0	—	0	0
18	mod. P.	—	0·03 P.	0·5 P.	—	0	0
19	mod. P.	—	—	0·8 P.	—	0	0
20	var. P.	—	0·12 P.	0·7 P.	—	..	0
1	mod. P.	str. N.	0·15 P. 0·40 N.	0·4 P.	—	0·75 P.	P.
22	str. P.	str. P.	0·22 P.	0	—	v. str. P.	P.
23	str. P.	mod. P.	0·2 P.	0	—	0·75 P.	0
24	str. P.	str. P.	0·12 P.	0	—	0·5 P.	0
25	var. P.	mod. P.	0·01 P.	0	—	0	0
26	str. P.	mod. P.	—	0·3 P.	—	0·5 P.	var. P.
27	str. P.	mod. N.P.	0·3 P.	0·1 P.	—	1 P.	P.
28	str. P.	mod. P.	0·07 P.	0	—	0·5 P.	P.
29	mod. P.N.	mod. P. str. N.	0·12 P.	0	—	0·75 P.	P.
30	mod. P.	mod. P.	0·07 P.	0·7 P.	—	0·5 P.	P.
December 1	weak P.	mod. P. slight N.	0·07 P.	0.2 P.	—	slight P.	N.
2	weak P.	mod. P.	0·10 P.	1·1 P.	—	0	N.
3	weak P.	mod. P.	—	0·4 P.	mod. N.	0·25 P.	P.
4	mod. P.	mod. P. str. N.	0·1 P.	0·9 P.	mod. N.	0	0
5	mod. P.	mod. P. str. N.	0·07 P.	0·7 P.	P.	weak P.	P.
6	mod. P.	str. P.	0·15 P.	0·5 P.	str. N.	0·25 P.	P.
7	str. P.	str. P.N.	0·17 P.	1·4 P.	mod. N.	0·5 P.	var.
8	mod. P.	str. P.	0·05 P.	0·1 P.	mod. N.	0	P.
9	mod. P.	mod. N. str. P.	0·07 P.	0·2 P.	mod. N.	0	var.
10	str. P.	str. P.	—	0·6 P.	mod. N.	—	—
11	str. P.	str. N.P.	0·22 P.	1·5 P.	mod. N.	—	—
12	str. P.	str. P.N.	0·25 P.	0·1 P.	mod. N.	—	—
13	mod. P.	str. P.	0·17 P.	0·1 P.	mod. N.	—	—
14	0	slight P.	0·0	0·0	mod. N.	—	—
15	0	str. P.	0·05 P.	1·0 P.	mod. N.	—	—
16	mod. P.	slight N. str. P.	0·02 P.	0·9 P.	—	—	—
17	mod. P.	str. N.	—	0·2 P.	N.	—	—
18	mod. P.	slight P.	0·10 P.	0	N.	—	—
19	mod. P.	str. P.	0·15 P.	2·4 P.	N.	—	—
20	mod. P.	mod. P. str. N.	0·05 P.	0	N.	—	—
21	mod. P.	str. N. slight P.	0·07 P.	0	N.	—	—
22	mod. P.	str. P.	0·02 P.	0	N.	—	—
23	mod. P.	str. P.	0·15 P.	0·2 P.	N.	—	—
24	mod. P.	str. N.	—	0·3 P.	N.	—	P.
25	mod. P.	str. P.	—	0	N.	—	0
26	mod. P.	str. P.N.	0·12 P.	0·4 P.	N.	—	P.
27	mod. P.	str. N.	0·12 P.	0·5 P.	N.	—	0
28	mod. P.	str. N.	0·20 P.	0·8 P.	N.	—	0
29	mod. P.	str. N.	0·25 P.	0·3 P.	N.	—	0
30	mod. P.	str. P.	0·10 P.	0	N.	—	P.
31	mod. P.	str. N.	—	0·1 P.	—	—	var.

From these Tables we learn that at Lewisham in September positive electricity was present on 27 days, and on three days not at all. In October it was positive on 28 days, negative on 2 days, both positive and negative on 3 days, and on one day none at all. In November positive electricity was present on 22 days; both positive and negative on 6 days, and none at all on 2 days. In December positive on 29 days, and none on 2 days. Then out of 122 days, from September 1 to December 31, common positive electricity was shown on 103 days, negative on 2 days; both negative and positive on 9 days, and on 8 days none was shown. Its strength was moderate and weak in September; frequently strong from the 6th of October till the beginning of December, and moderate and weak throughout this month.

At the Board of Health observations were began on September 28; and from this time to the end of the year, positive electricity was noted on 70 days, and negative on 7 days; on three days none at all. At Millbank Prison observations were began on October 26, and positive electricity was noted on 55 days, negative on 31, and none on three days.

At St. Thomas's Hospital positive electricity was noted in October on 24 days, negative on 1 day, and none on 5 days; in November positive electricity on 17 days, negative on 1 day, and none on 12 days; in December positive on 25 days, and none on 6 days. Thus out of 92 days, from October 1, positive electricity was noted on 66 days, negative on 2 days, and none at all on 23 days.

At St. Mary's Hospital the observations began on October 1, and ceased on December 9; within this interval on 28 days positive electricity was noted, on 3 days negative electricity, and on 36 no electricity at all.

At Highgate the observations began on October 1, and with the exception from December 10 to December 23, continued to the end of the year. Positive electricity was noted 44 times, negative 9 times; on 23 days the instrument was unaffected.

It is desirable to direct some attention to those days on which negative electricity was noticed at some stations and positive at others. On October 3, 4, and 5, negative electricity was noticed at the Board of Health; on the 6th negative electricity was shown at the low stations and positive at the high; on the 12th, 14th, 15th, and 16th, negative electricity was noticed at Highgate, and positive at other stations; on the 17th negative at Lewisham and Highgate, and positive at intermediate stations; on the 18th positive at south stations and negative at north; on the 20th negative at St. Mary's Hospital and positive elsewhere; from the 27th to the 30th negative at Millbank Prison. On November 4th the electricity was positive and negative at the different stations, and variable in strength; on the 21st it was negative at Millbank and the Board of Health. In December it was negative at Highgate on the 1st and 2d, and was frequently negative at Millbank Prison, and almost always negative at Poplar during the month. With these exceptions, the observations of atmospheric electricity taken at the several stations were in close accordance w[illegible] other, both in kind and in tension.

Ozone.

I rejoice that the persevering spirit of inquiry which distinguishes the present age should have added another meteorological element of investigation to the preceeding, one too, which if somewhat verging upon the field of chemical inquiry, promises to be a subtle and important agent in aid of this research into the nature and extent of meteorological influences upon the rise and progress of cholera. That these influences are great it is not possible to doubt, and equally impossible it is to believe that uncombined with others they are sufficient to account for the sudden and formidable growth of a disease, which in a few weeks from hitherto unexplained causes rises with giant strides into a devastating power, more formidable than any our country has yet known, and which with even greater rapidity has subsided, to be renewed, when we know not, unless a series of investigations like the present shall reveal to us the conditions of its rise and progress. The conjoining here a link of inquiry from a field so fraught with importance to the entire investigation as that of chemistry, I consider greatly in aid of this inquiry, and purpose to discuss the ozone observations at my command with the utmost rigour.

Ozone, first discovered by Dr. Schonbein in 1848, has since that date in England been sedulously investigated by Dr. Moffat. This indefatigable observer considers it to exercise an important influence on the animal economy, and believes that it may be found a means of materially inducing or modifying diseased actions, in which opinion he is supported by Dr. Schonbein.

In order to investigate the daily developments of this agent in the atmosphere during the epidemic of cholera, strips of test paper, as purchased from Mr. Cox at Peckham, and which he assured me he had received direct from Professor Schonbein's agent, were distributed to all the metropolitan stations; and other test papers, prepared by Dr. Moffat himself, were similarly distributed. The directions for noting the presence and measuring the amount of ozone are very simple, being the free exposure to the atmosphere (protected from rain and the direct rays of the sun) of a small strip of dry paper, previously saturated with a solution of starch and chemically pure iodide of potassium. The discoloration of this paper on exposure, to brown, or when immersed in water, to purple, attests the presence of ozone, and the degree of discoloration its intensity and amount, these changes in the paper are caused by the iodine being set free, through its power of oxidising the potassium of the iodide.

In the course of the observations, a test paper of each kind was exposed in the morning and evening daily at every station. It was found that the papers prepared by Dr. Moffat, were more sensitive than those of Dr. Schonbein, and accordingly indicated the presence of ozone when none was indicated by those of Schonbein. The following results are therefore based entirely on Moffat's papers.

From August 24 till September 4 there was no ozone at any station near the metropolis, and very little at any station over the country; a little was shown on September 5, and from this time afterwards was exhibited generally. It was most abundant on September 24, October 7, 8, 11, 18, 25, November 19, 20, 24, 25, and 26.

The following Table shows the mean amount in each week, the greatest *intensity being represented* by 10.

TABLE XXXVIII.—Weekly Amount of Ozone at the Different Stations.

Name of Station.	Week Ending																
	September				October				November				December				
	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30
Sydenham - - -	..	..	..	..	..	3·1	3·7	4·4	6·7	0·7	3·3	..	..	..	..	..	..
Lewisham - - -	0·3	1·4	2·2	0·3	0·7	0·7	0·4	0·7	0·0	0·0	0·0	0·7	1·2	1·3	0·4	1·0	2·1
Bexley Heath - -	2·9	1·5	2·0	1·4	2·9	2·4	2·4	1·0	1·2	0·6	2·1	2·0	1·1	1·7	2·6	2·4	2·9
Brixton Road - -	0·0	0·4	1·0	0·0	0·3	0·0	0·0	0·0	0·0	0·0	0·0	0·0	..	..	..	..	..
Camberwell - -	0·0	0·1	0·0	0·0	0·0	0·0	0·0	0·0	..	..	..	..	..	..	..	..	..
Battersea - - -	0·0	0·0	0·0	0·0	0·6	0·1	0·6	1·9	0·1	0·0	0·0	0·0	0·0	..	..	..	..
Dreadnought - -	0·0	0·0	0·0	0·2	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	..	..	..	..
Millbank - - -	..	..	0·1	0·5	0·7	0·6	0·4	0·6	0·2	1·2	..	..	..	..	..	0·9	0·0
Brompton - - -	..	..	2·8	0·5	1·1	0·4	1·0	0·1	0·4	0·6	0·0	0·0	0·0	..	..	..	..
Board of Health - -	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
St. Thomas's Hospital -	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
Poplar - - -	..	..	0·0	0·0	0·4	0·0	0·0	0·0	..	..	..	..	..	..	..	..	..
Somerset House - -	0·0	0·0	0·0	0·0	0·1	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
St. Mary's Hospital - -	0·0	0·2	2·0	1·0	0·4	0·0	..	..	..	..	..	..	..	..	..	..	..
Bethnal Green - -	..	0·0	0·0	0·0	0·1	0·1	0·1	0·0	0·0	0·0	0·3	0·2	0·0	0·0	..	..	..
St. Pancras - - -	0·0	0·0	0·2	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	..	..	..	..	..
Highgate - - -	0·4	0·9	1·1	1·4	2·1	2·2	2·4	1·5	0·1	0·7	1·1	3·4	1·8	1·3	1·6	..	1·3
Means - - -	0·3	0·3	0·8	0·3	0·6	0·6	0·7	0·7	0·6	0·3	0·5	0·4	0·4	0·6	0·8	0·7	0·9

From this Table we learn that the amount of ozone at all stations of low elevation has been insignificant, and that at many places near the river no trace of it at all has been detected throughout the whole of the cholera period. On the other hand, at places of high elevation, ozone has been shown nearly at all times, and at other and intermediate stations has been shown occasionally. The presence and amount of ozone, from these observations, would seem to be graduated by the elevation, and to increase as we ascend from the lowest to the highest ground.

Rain.

The fall of rain over the metropolis I considered would be sufficiently well determined by having observations made at two stations to the north, and two to the south, with the addition of observations from three or four of the central stations. The next Table gives the results of the rain-fall at these places.

TABLE XXXIX.—WEEKLY RAIN-FALL at the DIFFERENT STATIONS.

NAME OF STATION.	WEEK ENDING																													
	JULY				AUGUST				SEPTEMBER					OCTOBER				NOVEMBER				DECEMBER				
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30
	in.	in.	in.	in.	in.	in.	in.	in.	in	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Lewisham - -	0·43	0·77	0·06	0·09	2·24	0·02	0·24	0·05	0·00	0·00	0·48	0·33	0·01	0·58	0·09	0·90	1·08	0·00	0·09	0·70	0·24	0·56	0·22	0·11	0·91	0·12
Royal Observatory	0·53	0·87	0·00	0·04	2·72	0·01	0·15	0·13	0·00	0·00	0·45	0·25	0·00	0·45	0·06	0·48	0·80	0·00	0·08	0·62	0·22	0·48	0·21	0·07	0·71	0·14
Brixton Road -	..	..	..	..	..	..	..	..	0·00	0·00	0·40	0·26	0·00	0·46	0·20	0·60	1·34	0·02	0·12	0·54	0·18	..	..	..	..	..
Board of Health -	..	..	..	..	..	..	..	..	0·00	0·00	..	..	..	0·44	0·11	0·66	0·80	0·02	0·11	0·54	0·20	0·53	0·25	0·23	0·85	0·24
St. Thomas' Hosp.	..	..	..	..	..	..	..	..	0·00	0·00	0·40	0·15	0·00	0·40	0·50	0·85	0·70	0·00	0·00	0·70	0·20	0·80	0·25	0·18	0·80	0·19
Chiswell Street -	..	..	..	..	..	..	..	..	0·00	0·00	0·39	0·18	0·00	..	0·13	0·78	0·78	0·02	..	..	..	..	..	..	..	..
St. Mary's Hosp. -	0·45	0·67	0·16	0·22	2·84	0·00	0·20	0·11	0·00	0·00	0·42	0·17	0·00	0·44	0·12	0·86	0·84	0·03	0·12	0·56	0·17	0·46	0·11	0·18	0·84	0·22
St. John's Wood -	0·50	0·78	0·16	0·31	3·09	0·03	0·21	0·12	0·00	0·00	0·38	..	..	..	..	..	..	..	..	0·59	0·21	0·62	0·13	0·23	0·90	0·21
Enfield Vicarage -	0·33	0·80	0·00	0·13	1·77	0·01	0·18	0·07	0·00	0·00	0·37	0·35	0·01	0·50	0·13	0·82	0·66	0·02	0·15	0·65	..	0·52	0·11	0·22	0·68	0·13
Means - -	0·45	0·78	0·08	0·14	2·53	0·01	0·20	0·10	0·00	0·00	0·41	0·24	0·00	0·41	0·17	0·74	0·88	0·01	0·10	0·61	0·20	0·57	0·18	0·17	0·81	0·18

The numbers in the lowest line give the weekly fall of rain over the Metropolis. By comparing the results from each station with these values, it will be seen, that there is, for the most part, a close agreement in the amount of rain-fall; the most remarkable difference is that shown in the week ending August 5, between the two stations of St. John's Wood and Enfield, the former showing an excess above the mean of 0·56 inch, and the latter a deficiency below it of 0·76 inch.

Out of the 136 days, between July 12 and November 25, rain fell on 43 days; it fell plentifully on August 1, 3, and 4; September 13; October 6, 19, 25; and November 16. On August 3, the fall amounted to 1·4 inch; it fell scantily on 18 days, each fall being less than four-hundredths of an inch, and on 7 other days it was less than one-tenth of an inch. In the period from August 24, (on which day rain fell to the depth of 0·02 inch,) till September 12, no rain fell, and none fell between September 23 and October 6. The quantity of rain which fell in September was much below the average. On 93 days out of the 136, ending November 25, no rain at all fell.

It is desirable, before proceeding further with the rain-fall, to know its average amount at one or more stations within the Metropolitan districts, as deduced from the mean of several years. For this purpose, I have two series of observations, the one at St. John's Wood, taken by George Leach, Esq., and the other at the Royal Observatory, Greenwich; the former station is situated to the north and the latter to the south of London, both series extending without interruption over 15 years. The results of these two series are shown in the following Tables.

TABLE XL.—Monthly Fall of Rain at the Royal Observatory, Greenwich, in Inches, from the Year 1840 to 1854.

Years.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1840	2·4	1·2	0·3	0·1	2·1	1·5	1·7	1·1	2·9	1·6	2·9	1·6
1841	2·1	1·3	1·3	1·9	2·1	2·7	3·6	2·2	4·0	6·0	3·7	2·4
1842	1·0	1·1	1·9	0·4	2·1	1·0	3·0	1·8	4·0	1·4	4·2	0·7
1843	1·4	2·4	0·5	1·7	3·8	1·3	2·4	3·6	0·5	4·3	2·3	0·4
1844	2·4	2·3	2·9	0·4	0·4	1·8	2·8	2·0	1·2	4·0	4·3	0·4
1845	2·4	0·9	1·5	0·6	2·2	1·9	1·9	3·1	2·1	1·4	2·4	2·0
1846	2·8	1·5	0·9	3·1	1·5	0·5	1·5	4·0	1·8	5·1	1·5	1·1
1847	1·4	1·4	0·8	1·0	1·4	1·5	0·7	2·0	1·6	2·0	2·0	2·0
1848	1·2	2·6	3·1	3·4	0·4	3·5	2·0	4·3	2·4	3·5	1·2	2·6
1849	1·6	2·2	0·5	2·2	3·9	0·2	2·9	0·5	3·3	2·7	1·5	2·4
1850	1·2	1·3	0·3	2·3	2·4	0·9	2·9	1·9	2·3	1·4	2·5	1·3
1851	2·7	1·2	4·1	2·3	0·8	1·3	4·3	1·5	0·4	1·8	0·6	0·6
1852	3·6	0·9	0·2	0·5	1·9	4·6	2·3	4·4	3·8	3·8	6·0	2·2
1853	2·0	0·9	1·5	3·1	1·6	2·8	6·0	2·2	2·4	4·3	1·5	0·7
1854	1·7	1·0	0·4	0·6	3·3	1·0	1·7	2·9	0·7	2·6	1·4	1·4
Means -	2·0	1·5	1·3	1·6	2·0	1·8	2·6	2·5	2·2	3·0	2·5	1·4

TABLE XLI.—MONTHLY FALL of RAIN at ST. JOHN'S WOOD, in Inches, from the Year 1840 to 1854.

YEARS.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1840	2·9	1·3	0·3	0·3	2·2	1·7	2·0	1·5	2·7	1·3	3·7	0·6
1841	3·1	1·1	1·1	1·7	2·3	2·5	2·6	2·6	3·8	4·7	3·3	2·2
1842	1·0	1·4	2·0	0·3	2·0	2·2	2·1	3·8	3·9	2·0	4·9	0·8
1843	1·3	2·6	0·5	1·9	5·2	1·2	2·2	3·7	2·1	4·2	2·1	0·6
1844	2·3	2·6	2·5	0·4	0·3	1·3	2·9	1·7	1·1	3·9	3·0	0·4
1845	3·2	1·1	1·6	1·0	2·3	1·4	2·4	2·6	1·5	1·5	2·3	3·0
1846	3·4	1·4	1·1	3·7	1·5	1·0	1·6	5·8	1·7	5·4	1·6	1·2
1847	1·3	1·0	0·9	1·1	1·8	1·6	0·8	1·4	1·8	1·9	1·3	1·9
1848	1·1	3·1	3·4	2·8	0·2	3·3	2·2	5·1	2·0	3·4	1·1	2·2
1849	2·6	2·6	0·7	1·9	3·5	0·5	2·9	0·8	2·8	1·2	1·4	1·9
1850	1·0	1·0	0·3	2·6	2·0	1·1	2·6	0·8	2·4	1·7	2·1	1·5
1851	3·5	1·0	4·3	1·6	0·6	1·2	3·7	2·9	0·4	2·1	0·4	0·6
1852	3·5	1·0	0·3	0·8	1·3	5·7	2·5	3·7	3·6	3·9	6·7	2·1
1853	2·7	1·1	1·7	3·1	2·2	2·4	5·2	1·8	2·1	4·3	1·3	0·6
1854	2·3	1·0	0·4	0·4	3·7	1·1	2·7	2·8	0·7	2·4	1·3	1·7
Means -	2·3	1·5	1·4	1·6	2·1	1·5	2·6	2·9	2·2	2·9	2·4	1·4

The numbers in the lowest line in each of these Tables give the mean monthly fall of rain, and by taking these means, we have the mean monthly fall of rain over the Metropolis as follows:—

TABLE XLII.—AVERAGE MONTHLY FALL of RAIN over LONDON

MONTH.	Fall of Rain.
	in.
January - - - - -	2·15
February - - - - -	1·50
March - - - - -	1·35
April - - - - -	1·60
May - - - - -	2·05
June - - - - -	1·65
July - - - - -	2·60
August - - - - -	2·70
September - - - -	2·20
October - - - - -	2·95
November - - - -	2·40
December - - - -	1·40

The sum of these is 24·55 inches, which is the mean yearly rainfall at London.

The following Table gives the monthly fall of rain in the year 1854 at the Metropolitan stations, from which I received :inuous registers.

TABLE XLIII.—MONTHLY FALL of RAIN over LONDON in the Year 1854.

STATIONS.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Lewisham - - -	1·7	1·1	0·4	0·7	3·6	1·2	2·1	2·3	0·8	2·6	1·6	1·4
Royal Observatory -	1·7	1·0	0·4	0·6	3·3	1·0	1·7	2·9	0·7	2·6	1·4	1·4
St. Mary's Hospital -	1·3	1·0	0·4	0·3	3·5	1·0	1·9	3·0	0·6	2·3	1·2	1·5
St. John's Wood -	2·3	1·0	0·4	0·4	3·7	1·1	2·7	2·8	0·7	2·4	1·3	1·7
Enfield - - -	2·1	0·9	0·3	0·5	3·3	1·0	1·3	1·8	0·7	2·1	1·2	1·3
Means - -	1·82	0·98	0·38	0·50	3·48	1·06	1·94	2·56	0·70	2·40	1·34	1·46

The numbers in the lowest line give the monthly fall of rain over the Metropolis during the year 1854. By comparing them with the numbers showing the mean monthly fall for London, it will be seen that there has been a deficiency of rain in every month, excepting in May and December.

The fall of rain in the Metropolis in the year 1854, was 18·62 inches, being 5·93 *less* than the average fall for the year.

Clouds.

The amount of cloud was observed at most of the stations, and the results are in close agreement with each other. The results are as follows, an overcast sky being represented by 10 and a cloudless sky by 0, and intermediate states by intermediate numbers:—

In the two weeks ending July 15,	the amount of cloud was	9
In the two weeks ending July 29,	„	5
In the four weeks ending Aug. 26,	„	8
In the two weeks ending Sept. 9,	„	3
In the two weeks ending Sept. 23,	„	6
In the week ending Sept. 30,	„	1½
In the week ending October 7,	„	6
In the week ending October 14,	„	4½
In the week ending October 21,	„	7½
In the week ending October 28,	„	5
In the week ending November 4,	„	3½
In the week ending November 11,	„	6
In the week ending November 18,	„	8½
In the week ending November 25,	„	8
In the week ending December 2,	„	6
In the week ending December 9,	„	5
In the week ending December 16,	„	6
In the week ending December 23,	„	7
In the week ending December 30,	„	5

Comparison of the Meteorology of London, Worcester, Liverpool, Dunino, and Arbroath.

The foregoing section closes the amount of meteorological data I have been able to collect within the prescribed limits of time and

place. I am now going to institute a brief comparison of London meteorology with that of Worcester, Liverpool, Dunino, and Arbroath, for the same period. For the means of comparison I am indebted to the observations carried on under my superintendence by some of my best observers, members of the British Meteorological Society; the insufficiency of these observations to supply the required data for this special investigation is to me a matter of regret, and arises from the circumstances that my inquiries hitherto have been directed to the study of meteorology as influencing climate, and scarcely at all to the meteorology of towns, which, as entering into a scheme for eliminating the laws of climate, would vitiate the accuracy of results intended to be of general application. For this reason I have instituted observations upon the outskirts of cities, and as far removed from their influence as possible; but that which is wanting to give value to the present inquiry is a definite knowledge of the meteorological condition of the towns above mentioned, of which I have chosen Worcester and Liverpool as being visited by the Cholera at about the same time as the Metropolis, but to a less degree, and Dunino and Arbroath, as being far north, and enjoying a comparative if not total immunity from the ravages of the Great Devastator.

To obtain the required knowledge, similar observations to those taken in the Metropolis should be instituted in the most considerable of our provincial towns, and more particularly in those where disease and Cholera have been the most rife. We should then ascertain, whether a similarity of meteorological conditions attended a comparative amount of Cholera, and whether, and if so to what extent, similar meteorological influences existing in the Metropolis extended to or found existence in the many populous cities and towns of the United Kingdom.

Having most completely under my daily observation meteorological records, applying to more than one hundred different localities in Great Britain, I am able to estimate with tolerable accuracy the influence of geographical position upon climate, and the amount of abnormal departure due to local and unremovable causes. Had I, in addition, for as many years directed my attention to the meteorology of towns and cities, I should now have been in a position to bring forward a mass of evidence respecting the cause of their comparative insalubrity, and have been enabled to perform more satisfactorily this important part of my inquiry.

It should, however, be borne in mind that meteorological research, involving so much continuous and constant aid, is far too laborious to be taken up without the stimulus of some definite and ulterior object; and the clear elucidating of the meteorological influences at work to cause the insalubrity of towns has until lately promised little repayment to those who would wish their amelioration. I have little hesitation in saying, that were the meteorology of our towns carefully ascertained and collated with that of the Metropolis, and both together with that of the country generally, of which last I have a foundation of many years continuous observations, that in a short time we should be in a condition to elucidate a clear *insight into* the meteorological causes of Cholera, Influenza, and

many phases of disease which now burst upon us with the suddenness and devastating power of a divine and wrathful visitation.

The conditions most favourable to health in all cases are an average degree of pressure, temperature, and humidity. A departure from these conditions at once tells upon the public health in a degree proportional to the amount of departure. Thus we see that in the country at large, in obedience to the laws of climate, an equal degree of health is not always to be enjoyed, nor an equal degree of mortality to be expected.

The more, therefore, in towns that these conditions are violated, the greater must be the departure from the standard of public health. That this standard is too widely departed from in many of our largest towns, is an undeniable fact, and an inquiry into the causes in operation to produce it is greatly to be desired; the more especially as we are well aware that it is among the lower orders of the population that the greatest mortality occurs, a fact which speakingly proclaims the cause in a great measure to be remedial.

That the main causes of insalubrity arise from the violation of the climatic laws applying to the district, is evidenced by the comparative salubrity of the outskirts of towns, where the natural conditions of the district are nearly always in force excepting when subjected to the impurities and disturbing town influences, which in certain states of the atmosphere diffuse themselves over the environs.

Our first care should be a comparison of the differences existing between the more salubrious parts of the large and least healthy towns and those particular districts which are least so. We should then find the actual amount of departure from the general laws of climate applying to the surrounding country, and ascertain with certainty the particular localities within the city which give rise to the disturbing influences. This comparison has not yet been made, nor can it be, excepting by previously organised arrangement.

I will, therefore, proceed to compare briefly the meteorological phenomena of London with simultaneous phenomena at the places already mentioned, and which are Worcester, Liverpool, Dunino, and Arbroath.

The following are the positions of these places:—

Names of Places.	Latitude.	Longitude.	Height above the level of the sea.	Names of the Observers.
London - -	51° 29′	° ′ ..	..	Various.
Worcester - -	52 15	2 10 W.	125	James D. Baldey, Esq., C.E.
Liverpool - -	53 25	3 0 W.	37	John Hartnup, Esq., F.R.A.S.
Dunino - -	56 16	2 49 W.	309	David Tennant, Esq., M.B.M.S.
Arbroath - -	56 34	2 38 W.	50	Alexander Brown, Esq.

The following are the results of this investigation:—

TABLE XLIV.—WEEKLY MEANS of ATMOSPHERIC PRESSURE.

NAME OF STATION.	Week ending: July 8	July 15	July 22	July 29	August 5	August 12	August 19	August 26	September 2	September 9	September 16	September 23	September 30	October 7	October 14	October 21	October 28	November 4	November 11	November 18	November 25
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in	in.	in.	in.	in.	in.	in.
London . .	29·769	29·853	30·114	30·151	29·864	30·010	29·968	30·067	30·371	30·335	30·014	30·115	30·250	29·878	30·198	29·652	29·685	30·275	30·275	29·625	29·568
Worcester . .	..	..	..	..	..	..	..	..	..	30·216	29·792	29·986	30·135	29·672	30·066	29·497	29·501	30·106	30·191	29·365	29·380
Liverpool . .	29·702	29·880	30·045	30·201	29·895	29·980	29·959	30·019	30·406	30·369	29·912	30·068	30·241	29·870	30·186	29·718	29·602	30·201	30·323	29·636	29·650
Dunino . . .	..	..	..	..	29·552	29·541	29·486	29·478	29·894	29·949	29·389	29·471	29·688	29·367	29·698	29·258	29·077	29·633	29·805	29·323	..
Arbroath . .	29·685	29·885	30·005	30·231	29·918	29·931	29·902	29·872	30·278	30·334	29·779	29·931	30·110	29·746	30·069	29·662	29·487	30·047	30·200	29·729	29·660

The numbers for London are those at the level of the sea, and those at Worcester may be reduced to the same level by increasing them by 0·140 in.; at Liverpool by 0·043 in.; at Dunino by 0·346 in.; and at Arbroath by 0·056 in. Increasing the readings by these amounts, and comparing the results with those of London, it will be found that the numbers at Worcester are in close agreement with those at London, except in the last two weeks, when there would seem to have been less air over Worcester. At Liverpool, till the week ending September 9, there was greater atmospheric pressure over London, excepting in the weeks ending July 8, 22, and August 26. The excesses were large in the weeks ending July 15, 29, August 5, September 2, and 9. In the week ending October 22, the excess of pressure at Liverpool over London was as large as 0·1 in. Taking the results from Dunino and Arbroath, as the representatives of the pressure in Scotland, it seems to have been generally less than in England, and at times to the amount of $\frac{1}{4}$ of an inch.

TABLE XLV.—Weekly Means of Daily Maximum Temperature.

Name of Station.	Week ending																				
	July				August				September					October				November.			
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
London - -	67·5	66·1	70·0	79·1	67·1	70·0	71·7	72·6	76·8	73·5	70·1	67·3	66·4	63·8	60·3	53·3	53·0	58·2	50·1	47·4	41·0
Worcester - -	..	..	..	..	..	..	..	..	..	75·9	74·9	68·4	69·8	62·5	62·6	54·6	53·1	58·3	51·5	47·7	43·4
Liverpool - -	63·1	63·2	69·4	69·6	68·2	67·8	65·0	66·0	70·3	70·4	68·6	63·6	63·0	59·5	59·1	52·7	51·5	56·2	51·7	47·2	43·0
Dunino - -	..	..	..	..	61·0	67·9	66·7	65·7	69·0	68·1	64·7	59·1	60·1	54·1	56·3	49·0	44·9	53·1	48·0	45·0	43·0
Arbroath - -	66·1	67·0	69·6	68·7	65·6	68·4	67·7	67·6	70·1	68·3	66·3	61·0	62·0	55·7	55·4	50·0	47·1	52·9	46·4	45·4	39·

From the numbers in this Table it will be seen that London day temperature was below that in Worcester generally; the greatest difference occurred in the week ending September 16; it was generally above that of Liverpool, amounting in the week ending July 29 to $9\frac{1}{2}$°, but in the following week it was below it by 1·1°. Usually the excess was from 1° to 6° The excesses above the stations in Scotland were from 3° to 10°.

TABLE XLVI.—WEEKLY MEANS of MINIMUM TEMPERATURE of AIR.

NAME OF STATION.	WEEK ENDING																				
	JULY.				AUGUST.				SEPTEMBER					OCTOBER				NOVEMBER			
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
London - -	51·5	50·6	52·8	55·0	54·0	53·2	50·5	52·3	54·5	48·5	51·9	50·7	44·9	46·4	44·8	41·5	38·6	42·6	36·2	36·5	33·6
Worcester - -	..	..	..	..	..	..	..	..	..	48·3	50·4	49·1	40 5	41·3	39·9	39·6	35·3	42·4	32·8	35·2	33·9
Liverpool - -	53·4	54·4	55·8	55·9	56·8	57·0	55·3	55·8	55·9	57·2	55·4	54·5	51·4	51·3	47·8	46·3	42·4	47·9	44·1	40·1	35·8
Dunino - -	..	..	..	..	49·6	53·7	49·9	51·3	53·0	53·1	49·4	45·3	46·7	42·0	40·6	39·6	34·4	41·6	36·6	36·7	33·0
Arbroath - -	49·1	49·0	50·7	46·9	50·3	50·1	45·9	48·0	49·6	49·1	47·0	44·4	44·6	40·6	38·1	38·7	30·6	40·4	34·7	37·3	30·6

From the numbers in this Table it will be seen that the night temperatures of London were from 1° to 5° higher than those of Worcester; from 2° to 9° below those of Liverpool; and were usually from 1° to 9° above those in Scotland.

TABLE XLVII.—Weekly Means of Daily Ranges of Temperature.

Name of Station.	Week ending																				
	July				August				September					October				November			
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
London - - -	16·0	15·5	23·1	24·1	13·7	16·8	21·0	20·2	23·1	24·7	18·4	16·1	21·6	19·4	15·4	11·9	14·4	15·7	13·9	11·4	8·3
Worcester - -	..	..	..	..	..	..	..	..	..	27·6	24·5	19·3	29·3	21·2	22·7	15·0	17·8	15·9	18·7	12·5	9·5
Liverpool - -	9·7	8·8	13·6	13·7	11·4	10·8	9·7	10·2	14·4	13·2	13·2	9·1	11·6	8·2	11·3	6·4	9·1	8·3	7·6	7·1	7·2
Dunino - - -	..	..	..	..	11·4	14·2	16·8	14·4	16·0	15·0	15·3	13·8	13·4	12·1	15·7	9·4	10·5	11·5	11·4	8·3	10·0
Arbroath - -	17·0	18·0	18·9	21·8	15·3	18·3	21·8	19·6	20·5	19·2	19·3	16·6	17·4	15·1	17·3	11·3	16·5	12·5	11·7	8·1	8·8

The daily range of temperature in London from these numbers was smaller than at Worcester; very much larger than at Liverpool; and generally larger than at Dunino and Arbroath.

TABLE XLVIII.—Weekly Means of Temperature of Air.

Name of Station.	Week ending																				
	July				August				September					October				November			
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
London - - -	57·8	56·8	63·3	66 1	59·1	60·2	59·9	61·1	65·4	60·7	61·0	58·1	55·5	54·0	52·2	47·1	45·5	50·3	43·5	42·8	37·5
Worcester - -	..	..	..	..	..	..	..	..	..	60·5	61·4	57·0	53·5	51·8	50·2	45·8	42·9	49·9	40·7	41·8	38·3
Liverpool - -	53·6	54·0	60·0	60·2	58·0	59·0	54·8	56·0	60·4	61·0	59·0	53·6	53·3	51·7	52·3	45·5	44·6	50·4	46·0	41·3	37·2
Dunino - - -	..	..	..	..	54·5	59·9	57·2	57·3	59·8	59·4	57·0	51·5	52·3	47·9	48·4	43·7	39·3	46·6	41·7	40·9	37·9
Arbroath - -	56·4	56·9	59·1	57·7	57·7	59·0	56·8	56·7	59·4	58·3	56·2	51·7	52·0	47·0	47·1	43·4	38·3	46·4	39·8	41·7	35·3

From these results it would appear that London was warmer than Worcester in every week, excepting in those ending September 16 and November 25, but the excesses were small; that London was warmer than Liverpool in every week excepting those ending September 9, October 7, and November 4 and 11; the excesses were the greatest till September 2; in the nine weeks ending this day, the average excess was 3½°; and these results also show that London was warmer than Scotland in every week, the weekly excess varying from 1° to 8°.

The following Tables give the hygrometrical results for the same stations. Table XLIX. contains the weekly means of the temperature of the Dew Point; Table L. those of the weight of vapour in a cubic foot of air; and Table LI. the degree of humidity, the state of complete saturation being represented by 100.

TABLE XLIX.—WEEKLY MEANS of TEMPERATURE of DEW POINT.

NAME OF STATION.	WEEK ENDING																				
	JULY				AUGUST				SEPTEMBER					OCTOBER				NOVEMBER			
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
London - - -	49·6	51·1	53·0	54·4	54·1	52·2	51·6	51·9	55·8	50·2	53·8	51·1	47·4	48·0	46·4	41·6	40·4	45·4	38·1	38·2	34·3
Worcester - -	..	..	..	..	..	..	..	..	..	57·7	59·0	54·9	51·1	46·7	47·6	41·6	39·7	46·8	38·9	33·0	35·6
Liverpool -	50·1	50·0	52·2	52·4	52·4	54·3	51·2	52·3	54·1	55·0	54·5	47·7	48·5	44·6	47·3	40·7	39·3	45·8	41·3	37·5	34·7
Dunino - - -	..	..	..	..	50·0	56·0	55·0	51·0	53·6	53·6	51·5	46·5	48·0	44·0	44·6	39·0	36·0	43·4	37·0	37·4	34·0
Arbroath - -	51·4	49·4	53·4	50·7	50·2	51·1	49·2	47·7	51·5	48·6	46·3	41·0	40·6	39·9	43·0	37·7	35·3	39·9	31·5	34·6	29·5

TABLE L.—WEEKLY MEANS of WEIGHT of VAPOUR in a CUBIC FOOT of AIR.

NAME OF STATION.	WEEK ENDING																				
	JULY				AUGUST				SEPTEMBER					OCTOBER				NOVEMBER			
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.
London - - -	4·1	4·4	4·6	4·8	4·8	4·5	4·3	4·5	5·2	4·2	4·8	4·4	3·9	4·0	3·8	3·2	3·1	3·6	2·8	2·8	2·6
Worcester - -	..	..	..	..	..	..	..	..	..	5·4	5·6	5·0	4·4	3·8	3·9	3·2	3·0	3·8	3·0	2·4	2·7
Liverpool - -	4·3	4·2	4·5	4·5	4·6	4·9	4·4	4·5	4·8	4·9	4·9	3·9	4·1	3·5	3·9	3·1	3·0	3·7	3·2	2·8	2·6
Dunino - - -	..	..	..	..	4·3	5·1	4·7	4·4	4·8	4·8	4·4	3·8	4·0	3·5	3·6	3·0	2·7	3·4	2·8	2·8	2·5
Arbroath - -	4·4	4·1	4·7	4·3	4·2	4·3	4·1	3·9	4·2	4·0	3·7	3·1	3·1	3·0	3·4	2·8	2·4	3·0	2·3	2·5	2·2

TABLE LI.—WEEKLY MEANS of DEGREE of HUMIDITY.

NAME OF STATION.	WEEK ENDING																				
	JULY				AUGUST				SEPTEMBER					OCTOBER				NOVEMBER			
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
London - - -	75	84	72	68	65	76	74	73	73	72	80	80	76	80	83	82	83	84	83	88	88
Worcester - -	..	..	..	..	..	..	..	..	..	91	92	94	92	84	91	86	89	90	94	73	91
Liverpool - -	89	87	77	77	83	86	87	88	81	82	86	82	86	79	84	85	83	86	85	88	92
Dunino - - -	..	..	..	..	86	80	87	81	81	82	83	85	87	87	89	85	89	90	85	88	87
Arbroath - -	85	77	82	79	78	77	78	74	77	72	72	70	68	78	87	82	84	80	76	78	82

From the numbers in these Tables it appears that the amount of water in the air has been nearly evenly distributed. The largest amount in London was in the week ending September 2, and was larger than at the other stations in this week; the air in London was, however, less humid generally than at the other stations, on account of its higher temperature.

ABLE LII.—Weekly Amount of Rain-Fall.

Name of Station.	July				August				September					October				November			
Week ending	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
London . . .	0·45	0·78	0·08	0·14	2·53	0·01	0·20	0·10	0·00	0·00	0·41	0·24	0·00	0·41	0·17	0·74	0·88	0·01	0·10	0·61	0·20
Worcester . .	..	..	..	..	..	..	..	..	0·00	0·00	0·17	0·46	0·09	0·16	0·41	0·85	0·50	0·17	0·26	0·90	0·06
Liverpool . .	1·71	0·46	0·10	0·10	0·46	0·18	1·40	0·46	0·00	0·00	1·11	0·64	0·05	0·07	0·62	0·41	1·16	0·40	0·35	1·04	0·55
Dunino . . .	..	..	..	..	..	0·25	0·35	0·41	0·00	0·02	0·55	0·39	0·15	0·84	0·33	0·30	0·90	0·61	0·39	2·52	0·58
Arbroath . .	0·88	0·26	0·15	0·11	0·60	0·26	0·19	0·52	0·00	0·02	0·44	0·37	0·21	0·38	0·19	0·34	0·67	0·59	0·34	1·80	1·00

It will be seen from this Table, that the greatest diversity has existed in the amount of rain-fall at these stations. In the fortnight ending September 9 no rain seems to have fallen over the country. During the whole time it fell most frequently and most abundantly at Liverpool. Out of the 147 days ending November 25, rain fell at London on 44 days, at Liverpool on 71 days, and at Arbroath on 58 days. At Worcester, out of the 86 days ending November 25, rain fell on 32 days, and at Dunino, out of the 112 days ending November 25, it fell on 43 days; so that rain fell the least frequently in London.

The Wind.

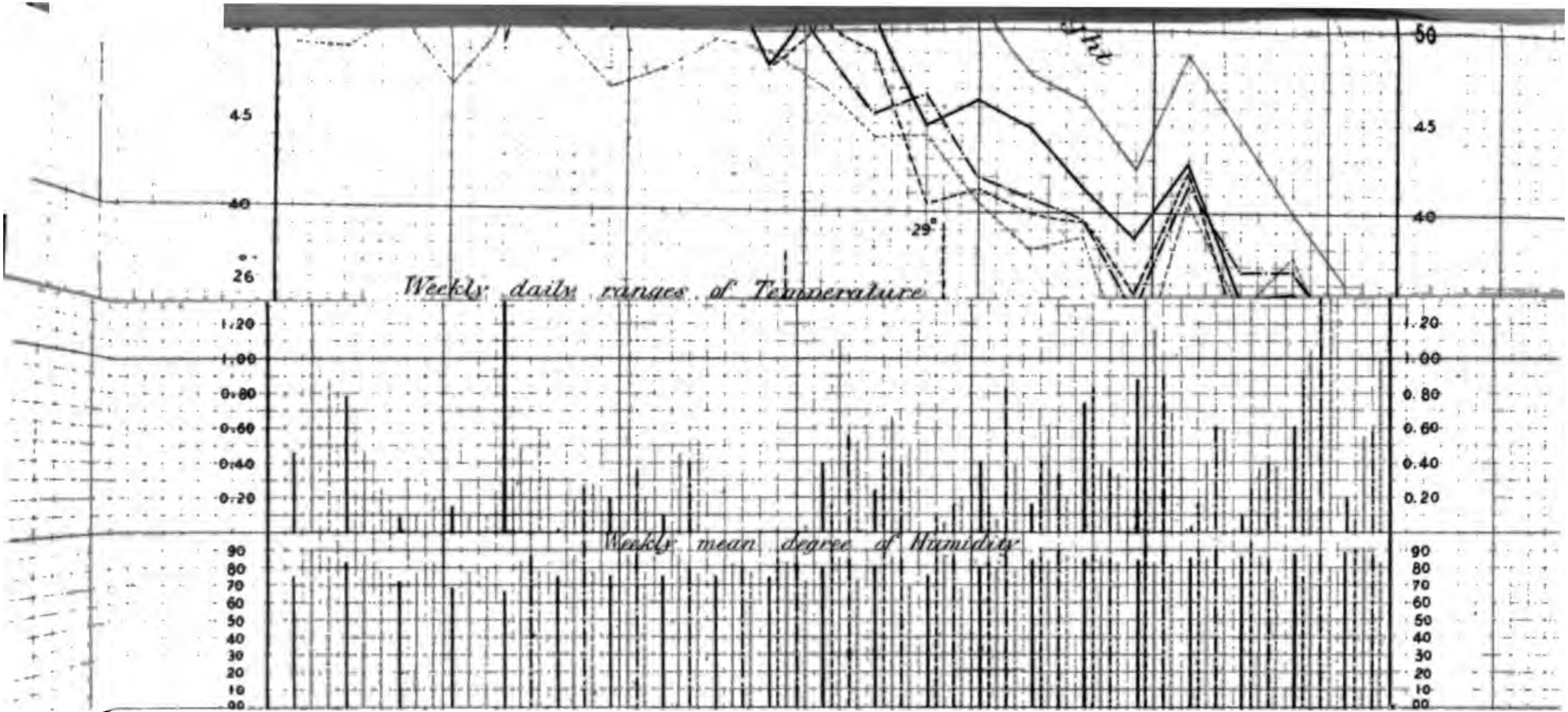
The direction of the wind at the different stations was chiefly S.W.; its estimated strength was nearly the same at the different stations. Its velocity at Liverpool is shown in the following Table:—

TABLE LIII.—Average daily HORIZONTAL MOTION of the AIR at LIVERPOOL OBSERVATORY.

Year.	January.	February.	March.	April.	May.	June.
	miles.	miles.	miles.	miles.	miles.	miles.
1852	460·0	445·6	216·8	223·4	302·0	325·5
1853	366·3	288·2	247·7	408·6	271·0	233·1
1854	368·0	460·7	334·5	307·6	253·3	302·3

Year.	July.	August.	September.	October.	November.	December.
	miles.	miles.	miles.	miles.	miles.	miles.
1852	250·6	255·3	269·2	278·2	303·2	421·5
1853	365·5	256·3	302·0	280·2	236·0	229·6
1854	248·4	273·4	306·1	317·3	332·7	..

These numbers do not agree with those for London in Table XXXIV.; and we draw from them the fact that there has been no deficiency in the velocity of the air at Liverpool, although in London the motion was less than one-half its average.



The black line indicates the phenomena at London.
The black dotted line indicates the phenomena at Worcester
The red line indicates the phenomena at Liverpool.
The long dotted black line indicates the phenomena at Dunino
The red dotted line indicates the phenomena at Arbroath.

The scales are at the sides of the Diagram.

TABLE XLIV.—Weekly Means of Atmospheric Pressure.

Name of Station.	Week ending																				
	July				August				September					October				November			
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in	in.	in.	in.	in.	in.	in.
London - -	29·769	29·553	30·114	30·151	29·864	30·010	29·968	30·067	30·371	30·335	30·014	30·115	30·250	29·878	30·198	29·652	29·685	30·275	30·275	29·625	29·568
Worcester - -	..	..	..	..	..	..	..	..	..	30·216	29·792	29·986	30·135	29·672	30·066	29·497	29·501	30·106	30·191	29·365	29·380
Liverpool - -	29·702	29·886	30·045	30·201	29·895	29·980	29·959	30·019	30·406	30·369	29·912	30·068	30·241	29·870	30·186	29·718	29·602	30·201	30·323	29·636	29·650
Dunino - - -	..	..	..	..	29·552	29·541	29·486	29·478	29·894	29·949	29·389	29·471	29·688	29·367	29·698	29·258	29·077	29·633	29·805	29·323	..
Arbroath - -	29·685	29·885	30·005	30·231	29·918	29·931	29·902	29·872	30·278	30·334	29·779	29·931	30·110	29·746	30·069	29·662	29·487	30·047	30·200	29·729	29·660

The numbers for London are those at the level of the sea, and those at Worcester may be reduced to the same level by increasing them by 0·140 in.; at Liverpool by 0·043 in.; at Dunino by 0·346 in.; and at Arbroath by 0·056 in. Increasing the readings by these amounts, and comparing the results with those of London, it will be found that the numbers at Worcester are in close agreement with those at London, except in the last two weeks, when there would seem to have been less air over Worcester. At Liverpool, till the week ending September 9, there was greater atmospheric pressure over London, excepting in the weeks ending July 8, 22, and August 26. The excesses were large in the weeks ending July 15, 29, August 5, September 2, and 9. In the week ending October 22, the excess of pressure at Liverpool over London was as large as 0·1 in. Taking the results from Dunino and Arbroath, as the representatives of the pressure in Scotland, it seems to have been generally less than in England, and at times to the amount of $\frac{1}{4}$ of an inch.

TABLE XLV.—WEEKLY MEANS of DAILY MAXIMUM TEMPERATURE.

NAME OF STATION.	WEEK ENDING																				
	JULY				AUGUST				SEPTEMBER					OCTOBER				NOVEMBER.			
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
London - -	67·5	66·1	76·0	79·1	67·1	70·0	71·7	72·6	76·8	73·5	70·1	67·3	66·4	63·8	60·3	53·3	53·0	58·2	50·1	47·4	41·9
Worcester - -	..	..	..	..	..	..	..	..	..	75·9	74·9	68·4	69·8	62·5	62·6	54·6	53·1	58·3	51·5	47·7	43·4
Liverpool - -	63·1	63·2	69·4	69·6	68·2	67·8	65·0	66·0	70·3	70·4	68·6	63·6	63·0	59·5	59·1	52·7	51·5	56·2	51·7	47·2	43·0
Dunino - -	..	..	..	..	61·0	67·9	66·7	65·7	69·0	68·1	64·7	59·1	60·1	54·1	56·3	49·0	44·9	53·1	48·0	45·0	43·0
Arbroath - -	66·1	67·0	69·6	68·7	65·6	68·4	67·7	67·6	70·1	68·3	66·3	61·0	62·0	55·7	55·4	50·0	47·1	52·9	46·4	45·4	39·

From the numbers in this Table it will be seen that London day temperature was below that in Worcester generally; the greatest difference occurred in the week ending September 16; it was generally above that of Liverpool, amounting in the week ending July 29 to $9\frac{1}{2}$°, but in the following week it was below it by 1·1°. Usually the excess was from 1° to 6°. The excesses above the stations in Scotland were from 3° to 10°.

TABLE XLVI.—WEEKLY MEANS of MINIMUM TEMPERATURE of AIR.

NAME OF STATION.	WEEK ENDING																				
	JULY.				AUGUST.				SEPTEMBER					OCTOBER				NOVEMBER			
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
London - -	51·5	50·6	52·8	55·0	54·0	53·2	50·5	52·3	54·5	48·5	51·9	50·7	44·9	46·4	44·8	41·5	38·6	42·6	36·2	36·5	33·6
Worcester - -	..	..	..	..	..	..	..	..	..	48·3	50·4	49·1	40 5	41·3	30·9	39·6	35·3	42·4	32·8	35·2	33·9
Liverpool - -	53·4	54·4	55·8	55·9	56·8	57·0	55·3	55·8	55·9	57·2	55·4	54·5	51·4	51·3	47·8	46·3	42·4	47·9	44·1	40·1	35·8
Dunino - -	..	..	..	..	49·6	53·7	49·9	51·3	53·0	53·1	49·4	45·3	46·7	42·0	40·6	39·6	34·4	41·6	36·6	36·7	33·0
Arbroath - -	49·1	49·0	50·7	46·9	50·3	50·1	45·9	48·0	49·6	49·1	47·0	44·4	44·6	40·6	38·1	38·7	30·6	40·4	34·7	37·3	30·6

From the numbers in this Table it will be seen that the night temperatures of London were from 1° to 5° higher than those of Worcester; from 2° to 9° below those of Liverpool; and were usually from 1° to 9° above those in Scotland.

TABLE XLVII.—Weekly Means of Daily Ranges of Temperature.

Name of Station.	Week ending																				
	July				August				September					October				November			
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
London	16·0	15·5	23·1	24·1	13·7	16·8	21·0	20·2	23·1	24·7	18·4	16·1	21·6	19·4	15·4	11·9	14·4	15·7	13·9	11·4	8·3
Worcester	..	..	..	..	..	..	..	..	..	27·6	24·5	19·3	29·3	21·2	22·7	15·0	17·8	15·9	18·7	12·5	9·5
Liverpool	9·7	8·8	13·6	13·7	11·4	10·8	9·7	10·2	14·4	13·2	13·2	9·1	11·6	8·2	11·3	6·4	9·1	8·3	7·6	7·1	7·2
Dunino	..	..	..	..	11·4	14·2	16·8	14·4	16·0	15·0	15·3	13·8	13·4	12·1	15·7	9·4	10·5	11·5	11·4	8·3	10·0
Arbroath	17·0	18·0	18·9	21·8	15·3	18·3	21·8	19·6	20·5	19·2	19·3	16·6	17·4	15·1	17·3	11·3	16·5	12·5	11·7	8·1	8·8

The daily range of temperature in London from these numbers was smaller than at Worcester; very much larger than at Liverpool; and generally larger than at Dunino and Arbroath.

TABLE XLVIII.—WEEKLY MEANS of TEMPERATURE of AIR.

NAME OF STATION.	WEEK ENDING																				
	JULY				AUGUST				SEPTEMBER					OCTOBER				NOVEMBER			
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
London - - -	57·8	56·8	63·3	66·1	50·1	60·2	59·9	61·1	65·4	60·7	61·0	58·1	55·5	54·0	52·2	47·1	45·5	50·3	43·5	42·8	37·5
Worcester - -	..	..	..	..	..	..	..	..	..	60·5	61·4	57·0	53·5	51·8	50·2	45·8	42·9	49·9	40·7	41·8	38·3
Liverpool - -	53·6	54·0	60·0	60·2	58·0	59·0	54·8	56·0	60·4	61·0	59·0	53·6	53·3	51·7	52·3	45·5	44·6	50·4	46·0	41·3	37·2
Dunino - - -	..	..	..	..	54·5	59·9	57·2	57·3	59·8	59·4	57·0	51·5	52·3	47·9	48·4	43·7	39·3	46·6	41·7	40·9	37·9
Arbroath - -	56·4	56·9	59·1	57·7	57·7	59·0	56·8	56·7	59·4	58·3	56·2	51·7	52·0	47·0	47·1	43·4	38·3	46·4	39·8	41·7	35·3

From these results it would appear that London was warmer than Worcester in every week, excepting in those ending September 16 and November 25, but the excesses were small; that London was warmer than Liverpool in every week excepting those ending September 9, October 7, and November 4 and 11; the excesses were the greatest till September 2; in the nine weeks ending this day, the average excess was $3\frac{1}{2}°$; and these results also show that London was warmer than Scotland in every week, the weekly excess varying from 1° to 8°.

The following Tables give the hygrometrical results for the same stations. Table XLIX. contains the weekly means of the temperature of the Dew Point; Table L. those of the weight of vapour in a cubic foot of air; and Table LI. the degree of humidity, the state of complete saturation being represented by 100.

TABLE XLIX.—WEEKLY MEANS of TEMPERATURE of DEW POINT.

NAME OF STATION.	WEEK ENDING																				
	JULY				AUGUST				SEPTEMBER					OCTOBER				NOVEMBER			
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
London - - -	49·6	51·1	53·0	54·4	54·1	52·2	51·6	51·9	55·8	50·2	53·8	51·1	47·4	48·0	46·4	41·6	40·4	45·4	38·1	38·2	34·3
Worcester - -	..	..	..	..	..	..	..	..	..	57·7	59·0	54·9	51·1	46·7	47·6	41·6	39·7	46·8	38·9	33·0	35·6
Liverpool -	50·1	50·0	52·2	52·4	52·4	54·3	51·2	52·3	54·1	55·0	54·5	47·7	48·5	44·6	47·3	40·7	39·3	45·8	41·3	37·5	34·7
Dunino - - -	..	..	..	..	50·0	56·0	53·0	51·0	53·6	53·6	51·5	46·5	48·0	44·0	44·6	39·0	36·0	43·4	37·0	37·4	34·0
Arbroath - -	51·4	49·4	53·4	50·7	50·2	51·1	49·2	47·7	51·5	48·6	46·3	41·0	40·6	39·9	43·0	37·7	35·3	39·9	31·5	34·6	29·5

TABLE L.—Weekly Means of Weight of Vapour in a Cubic Foot of Air.

Name of Station.	Week ending																				
	July				August				September					October				November			
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.	gr.
London - - -	4·1	4·4	4·6	4·8	4·8	4·5	4·3	4·5	5·2	4·2	4·8	4·4	3·9	4·0	3·8	3·2	3·1	3·6	2·8	2·8	2·6
Worcester - -	..	..	..	..	..	..	..	..	..	5·4	5·6	5·0	4·4	3·8	3·9	3·2	3·0	3·8	3·0	2·4	2·7
Liverpool - -	4·3	4·2	4·5	4·5	4·6	4·9	4·4	4·5	4·8	4·9	4·9	3·9	4·1	3·5	3·9	3·1	3·0	3·7	3·2	2·8	2·6
Dunino - - -	..	..	..	..	4·3	5·1	4·7	4·4	4·8	4·8	4·4	3·8	4·0	3·5	3·6	3·0	2·7	3·4	2·8	2·8	2·5
Arbroath - -	4·4	4·1	4·7	4·3	4·2	4·3	4·1	3·9	4·2	4·0	3·7	3·1	3·1	3·0	3·4	2·8	2·4	3·0	2·3	2·5	2·2

TABLE LI.—Weekly Means of Degree of Humidity.

Name of Station.	Week ending																				
	July				August				September					October				November			
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
London - - -	75	84	72	68	65	76	74	73	73	72	80	80	76	80	83	82	83	84	83	88	88
Worcester - -	..	..	..	..	..	..	..	..	..	91	92	94	92	84	91	86	80	90	94	73	91
Liverpool - -	89	87	77	77	83	86	87	88	81	82	86	82	86	79	84	85	83	86	85	88	92
Dunino - - -	..	..	..	..	86	80	87	81	81	82	83	85	87	87	89	85	80	90	85	88	87
Arbroath - -	85	77	82	79	78	77	78	74	77	72	72	70	68	78	87	82	84	80	76	78	82

From the numbers in these Tables it appears that the amount of water in the air has been nearly evenly distributed. The largest amount in London was in the week ending September 2, and was larger than at the other stations in this week; the air in London was, however, less humid generally than at the other stations, on account of its higher temperature.

ABLE LII.—Weekly Amount of Rain-Fall.

Name of Station.	Week ending																				
	July				August				September					October				November			
	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
London - - -	0·45	0·78	0·08	0·14	2·53	0·01	0·20	0·10	0·00	0·00	0·41	0·24	0·00	0·41	0·17	0·74	0·88	0·01	0·10	0·61	0·20
Worcester - -	..	..	..	..	..	..	..	..	0·00	0·00	0·17	0·46	0·09	0·16	0·41	0·85	0·50	0·17	0·26	0·90	0·06
Liverpool - -	1·71	0·46	0·10	0·10	0·46	0·18	1·40	0·46	0·00	0·00	1·11	0·64	0·05	0·07	0·62	0·41	1·16	0·40	0·35	1·04	0·55
Dunino - - -	..	..	..	..	..	0·25	0·35	0·41	0·00	0·02	0·55	0·39	0·15	0·84	0·33	0·36	0·90	0·61	0·39	2·52	0·58
Arbroath - -	0·88	0·26	0·15	0·11	0·60	0·26	0·19	0·52	0·00	0·02	0·44	0·37	0·21	0·38	0·19	0·34	0·67	0·59	0·34	1·80	1·00

It will be seen from this Table, that the greatest diversity has existed in the amount of rain-fall at these stations. In the fortnight ending September 9 no rain seems to have fallen over the country. During the whole time it fell most frequently and most abundantly at Liverpool. Out of the 147 days ending November 25, rain fell at London on 44 days, at Liverpool on 71 days, and at Arbroath on 58 days. At Worcester, out of the 86 days ending November 25, rain fell on 32 days, and at Dunino, out of the 112 days ending November 25, it fell on 43 days; so that rain fell the least frequently in London.

Atmospheric Phenomena in relation to Cholera in the Metropolitan Districts in the Year 1854.

Having discussed the different meteorological conditions weekly which prevailed during the continuance of Cholera in the Metropolis, it is necessary to trace the progress of the disease weekly in connexion with the meteorology of the period.

From the beginning of the year till the week ending July 8, the mortality from diarrhœa averaged 35 weekly; till this time 21 deaths only had been caused by Cholera, and these were scattered over the 27 weeks from January 1. In the week ending July 15 six cases of death from Cholera and 59 from diarrhœa were registered The weekly progress of the disease was subsequently as follows:—

TABLE LVIII.—SHOWING the NUMBER of DEATHS in the METROPOLIS from CHOLERA and DIARRHŒA, in each week from July 1 to the end of the Year 1854.

1854. — WEEK ENDING	Number of Deaths from Cholera.	Number of Deaths from Diarrhœa.
July 1 - - -	0	38
8 - - -	4	59
15 - - -	6	59
22 - - -	33	79
29 - - -	180	122
August 5 - - -	488	187
12 - - -	671	237
19 - - -	772	225
26 - - -	869	245
September 2 - - -	1,646	251
9 - - -	1,869	289
16 - - -	1,527	252
23 - - -	1,182	206
30 - - -	658	166
October 7 - - -	398	120
14 - - -	227	122
21 - - -	143	103
28 - - -	48	58
November 4 - - -	25	54
11 - - -	16	50
18 - - -	10	44
25 - - -	5	27
December 2 - - -	4	30
9 - - -	2	24
16 - - -	0	37
23 - - -	2	32
30 - - -	0	13

It is desirable to trace the progress of these numbers with each section separately.

The *pressure of the atmosphere*, as shown in Table IV., was in excess in the months of February, March, April; in defect in May and June; and slightly in excess in July. The reading of the barometer became remarkable towards the end of August, and the pressure was more continuously great during the worst period of the disease than at any other time. On reference to Table III. and the notes which follow, it will be seen that the barometer reading was as high as 30½ inches on three different days between August 25 and September 10, and that it exceeded 30 inches during the whole of this period. The reading began to decrease on the 11th, when the disease also began to decline.

The readings declined below 30 inches on the 14th, and continued with but slight variations from 30 inches till after the 20th. The mortality from cholera in the week ending September 16, was 342 less than in the preceding week. On September 22 the reading attained 30·4 inches nearly, and was high till the end of the month. The decrease in the mortality in the week ending September 23 was 345, but was greater in the week ending September 30, the decrease being as large as 524, notwithstanding the still high reading of the barometer. After this time the rate of decline steadily continued till the end of October, after which a few scattered cases only occurred till the end of the year. The reading of the barometer decreased to 29·37 inches by October 5, and increased to 30·6 by the 13th; declined to 29·3 inches by the 18th; after this time the variations of reading were frequent, and at times large in amount. The reading in November was that of the average, but was below it in December.

Temperature of the Air.

Table IX., with following remarks, shows the temperature of each month in the year 1854, and its departure from the average. From January 1 to April 21, with the exception of 16 days, viz., January 1 to January 6, and February 10 to February 19, the mean daily temperature of the air was in excess. The average daily excess of the 101 days ending April 21 was 3·4°; on April 22 a very cold period set in, injuring vegetation and killing many hardy plants, and from this time to July 19, a period of 97 days, the average daily defect of temperature was 3·3°. In Table VIII. the departures of temperature each week, from July 8, at the central Metropolitan stations, are given. During the first two weeks the temperature was between 4 and 5 degrees below the average, but on July 20 it rose above, and on the 25th was 11° in excess; the temperature of the air on this day rose to 90° nearly, and was the hottest in the year. The mean weekly temperature in the 3 weeks ending August 19 was in defect. From August 19 till October 11 the temperature was in excess, averaging for these 54 days 2·6° daily. The greatest excesses were in the week ending September 2, when the average amount for the Metropolitan districts was 6¼°; the number of deaths from Cholera this week were 1,646,

TABLE LIV.—Showing the Weekly Amount of Ozone at the different Stations.

Names of Stations.	Week ending, 1854.																										Names of Observers.	Heights of Stations.
	July 8.	July 15.	July 22.	July 29.	August 5.	August 12.	August 19.	August 26.	September 2.	September 9.	September 16.	September 23.	September 30.	October 7.	October 14.	October 21.	October 28.	November 4.	November 11.	November 18.	November 25.	December 2.	December 9.	December 16.	December 23.	December 30.		
																												feet.
Wakefield - -	0·9	1·3	0·6	2·3	2·9	0·0	0·1	0·7	0·3	0·2	0·4	0·0	..	0·0	0·0	0·2	0·0	0·0	0·0	0·0	0·1	1·3	0·6	0·2	0·1	0·4	W. R. Milner, Esq., M.B.M.S. -	115
Liverpool - -	1·6	1·4	0·1	0·9	2·2	0·9	0·9	1·2	0·7	1·0	0·6	3·0	3·0	1·7	2·5	1·7	1·0	3·0	3·1	0·0	0·3	..	..	..	..	..	John Hartnup, Esq., F.R.A.S. -	37
Hawarden - -	3·0	0·4	1·7	0·4	0·3	1·7	2·0	2·7	0·1	0·0	3·4	6·2	1·6	1·3	1·6	4·0	3·7	6·3	3·0	3·6	1·7	4·7	6·4	6·7	7·1	5·9	Dr. Moffat, M.B.M.S. - -	290
Grantham - -	0·3	1·0	0·0	0·6	1·6	0·7	0·0	0·9	0·0	0·9	1·1	1·9	1·1	1·4	1·4	1·3	0·6	0·1	0·0	0·9	1·6	1·4	2·6	2·7	2·5	2·9	J. W. Jeans, Esq., M.B.M.S. -	190
Norwich - - -	..	..	..	..	1·9	0·8	0·9	0·0	0·8	1·0	1·1	2·1	0·9	1·2	1·4	1·6	1·2	..	..	..	..	..	..	..	..	..	W. Brooke, Esq., M.B.M.S. -	30
Bedford - - -	0·0	0·0	0·0	0·3	1·0	0·9	0·0	0·7	0·0	0·0	0·3	1·1	0·0	0·0	0·3	..	..	..	..	..	..	..	0·3	0·1	0·1	0·1	Dr. Barker, M.B.M.S. - -	100
Hartwell House, Aylesbury - -	6·1	6·0	2·3	4·4	5·5	4·2	3·5	4·6	2·4	4·6	4·7	0·7	3·8	..	..	..	..	..	..	..	..	..	..	..	..	..	Dr. Lee, F.R.S., M.B.M.S. -	250
Swansea - - -	6·3	3·1	5·6	2·6	4·8	1·2	0·4	3·2	0·0	0·0	2·4	5·0	0·8	2·0	2·1	3·0	1·1	2·4	3·1	0·9	1·4	4·3	4·1	5·9	4·3	..	M. Moggridge, Esq., M.R.C.S. -	85
Uckfield - - -	1·9	0·9	1·7	1·2	1·3	0·5	1·1	0·7	1·1	1·8	1·1	1·2	0·6	1·5	1·4	1·4	2·8	2·8	1·5	2·8	1·4	1·3	2·3	1·9	0·4	0·9	C. L. Prince, Esq., M.B.M.S. -	180
Ryde - - -	2·4	1·5	1·5	0·9	2·7	1·2	1·3	0·9	0·0	0·9	3·9	3·1	0·5	2·0	1·6	0·0	1·9	0·5	0·1	0·1	0·0	4·1	4·6	2·4	..	3·4	B. Barrow, Esq., M.B.M.S. -	110
Exeter - - -	2·3	0·3	2·3	1·6	1·4	1·4	1·0	0·9	0·0	0·2	3·6	1·1	1·0	1·1	0·5	0·7	1·1	1·1	1·4	0·5	0·2	1·4	2·2	2·4	1·8	1·1	Dr. Shapter, M.B.M.S. - -	140
Teignmouth - -	3·4	2·3	3·0	0·5	2·2	0·9	2·4	2·7	0·7	1·6	2·9	4·1	1·1	3·1	2·8	4·0	4·3	2·5	3·6	3·2	3·4	4·0	6·2	5·8	5·5	3·2	W. C. Lake, Esq., M.B.M.S. -	70
Guernsey - - -	..	1·0	0·1	0·6	0·3	0·9	0·1	2·9	0·8	2·1	..	..	..	2·6	1·4	2·7	2·6	0·6	1·5	1·4	1·8	2·6	2·4	3·4	5·1	2·9	Dr. Hoskins, F.R.S., M.B.M.S. -	123
Means - - -	2·6	1·6	1·6	1·3	2·2	1·2	1·1	1·7	0·6	1·1	2·1	2·7	1·3	1·5	1·4	1·9	1·8	1·5	1·7	1·3	1·2	2·8	3·2	3·2	3·0	2·7		

all stages of decay, and which derive accession from the refuse cast upon the banks of the river, and left by the receding tide upon the mud. The vapours thus generated mix with the atmosphere, and in calm weather are retained in its lower stratum, subjecting the inhabitants within and around their dwellings to their poisonous influence.

The effect of temperature upon the Thames water, in* tainting the surrounding air, is exhibited in the well-known fact that diarrhœa and summer cholera become prevalent after the temperature of the Thames has attained to 60°, and from the fact that as the water declines from this temperature, so also do the above diseases.

By reference to Table XIX. and following remarks, it will be seen that the temperature of the Thames attained to 60° on June 22, and descended below this reading on September 26 ; that the temperature of the water was 70° towards the end of July, fell to 62° at the beginning of August, and attained a second maximum of 66° at the beginning of September.

Here then, according to the above reasoning, is a cause for the prevalence of disease in general, if not of Cholera, during the period under review; the insalubrity of which was greatly heightened by the weather at the time being close and sultry, and distinguished everywhere by a continued prevalence of mist and haze. During periods of clear calm weather in the Metropolis, that is, when the Londoner sees the sky really blue, and at night when he sees the stars shine brightly, or when the air is in gentle motion, the vapours from the city and river ascend high into the atmosphere, become generally diffused, and escape observation; but during periods of cloudy, misty weather, and particularly during calms and the cold air of nights, the vapour in ascending is condensed into haze, mist, or fog, and kept in contact with the surface of the earth, occupying the lowest districts.

The greater the difference in relation to the temperatures of the air and water, the more dense will be the mist or fog. Table XX. gives these differences, and exhibits in some instances an excess of 20° temperature of the Thames over that of the air. In the remarks following this Table, it will be seen that for 28 nights ending September 12 the average excess exceeded 16·5°.

By reference to the wind sections for this period, it will be seen that the air was calm both by day and night. It was, therefore, charged with the accumulated vapours for this long time, and fatally was their influence manifested during the three weeks when the disease was at its worst, and destroyed 5,834 of the Metropolitan population.

No reasonable doubt can henceforth be entertained as to the pernicious effect of the London fogs during the summer heats, nor of their power, under any favourable combination of unusual heat or general stagnation of the air, to fan into flame the dormant sparks of an epidemic never thoroughly extinguished since its first introduction to English soil.

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* See the Registrar-General's Report upon Cholera in England in 1848 and 1849.

Wind.

The first strong wind in the year was on January 3, when from the E.N.E. there were pressures to 4 and 5 lbs. on a square foot of surface. On January 25 the wind blew strongly for a short time from the south, and on the 26th from the S.W. In February, from the 4th to the 9th, the wind blew almost continuously from the west and S.W., with pressures from 3 to 5 lbs.; on the 9th a pressure of 12 lbs. was recorded. The next strong wind was on February 17 from S.W. and W., with pressures varying from 5 to 12 lbs.; and on the 18th and 19th from the N.W., with pressures from 5 lbs. to 10 lbs., and in one instance to 18 lbs. On February 23, 24, and 25 there were pressures of 3 lbs. and 4 lbs. from the S., S.W., and N.N.W.; from March 8 to 11 there were occasional pressures of 3 lbs. from S.W. The next strong wind of any duration was on April 22 and 23 from the N.E., when there were pressures to 5 lbs. and 6 lbs. On April 28 there were pressures to 5 lbs. from the N.; on April 30 there were occasional pressures to 4 lbs. from the S.W. On May 2 there were pressures to 6 lbs. from the S.W. On May 7 and 8 the wind blew strongly from W.S.W., and pressures to 8 lbs. and 10 lbs. were recorded. On June 2 and 3 the wind blew for some time with pressures to 4 lbs. and 5 lbs. from the N.E. On June 10 and 11 the wind blew from the S.W. with pressures to 4 lbs. and 5 lbs. On June 26 there were pressures from the W.S.W. for some hours to 4 lbs. Up, therefore, to the end of June there had been instances of strong wind, though somewhat fewer than usual. Up to this time few deaths from Cholera had occurred, and those were scattered from the commencement of the year. In July there were no strong winds, and 16 days were noticed as nearly or quite calm. In the second week of the month 5 cases of Cholera were reported; in the week ending July 22 the numbers increased to 26, and subsequently to 133 in the last week; whilst the deaths from diarrhœa increased from 27 to 84. In August, by reference to Table XXXV., it will be seen that 6 out of the first 10 days were designated as calm. By the week ending August 12 the number of deaths had increased to no less than 644. On August 11 the air moved more freely from the W.S.W., and on the 12th from the S. and S.W. From the 13th to the 18th, portions of each day were calm; from the 19th the air was in gentle motion till the 23d; and on the 24th there were pressures to 2 lbs. and 3 lbs. for a few hours from the W.S.W. At intervals, when the air was somewhat less stagnant, the rate of increase in the disease was checked, dating from August 12. In the weeks ending August 26 the number of deaths from Cholera was 847. From August 25 to September 11 the air was still, and a dead calm prevailed at all low places. This was the calmest period in the year, and the disease was at its height. The number of deaths from Cholera in the week ending September 9 amounted to 1,869, and from diarrhœa to 289. By reference to the remarks following Table XXX. it will be seen that from July 1 to September 11 the direction of the wind was alternately from S.W. and N.E., and for an equal number of days; but on those days in which it was passing from the latter

point it was mostly in gentle motion only. On September 12 the wind blew for a couple of hours with a pressure of 2 lbs. on the square foot, and the air became in motion even in places situated near the alluvial of the Thames. Shortly after the disease began to decline. From September 3 to September 20 the wind blew every day with velocity for some time, and the disease declined rapidly. On September 24 the wind blew strongly for some hours, with pressures varying from 5 lbs. to 7 lbs. on the square foot. This was followed by a calm, extending to October 2: the disease, nevertheless, continued to decline. On October 5 the wind blew for a few hours from the S.W., with a pressure of 3 lbs. During the month of October the wind occasionally passed with some velocity; still there were 12 days partially calm; the disease declined to 25 in the week ending the 4th of November.

In the remarks following Table XXXV. it is shown that out of the 123 days from July 1 to the end of October a calm more or less prevailed on 65 days, which is more than one half of the entire number. After November 16 there was no day on which the air was calm; a few fatal cases of Cholera, however, continued to occur.

By reference to Table XXXVI. and following remarks, it will be seen, that the air was at all times in much less motion at places situated on the alluvial of the river Thames, than where situated on higher ground. In connexion with the progress of the disease, we perceive that at such places the epidemic has been more severe, committing its greatest ravages at Lambeth, Walworth, Bermondsey, Rotherhithe, Deptford, Poplar, &c. At these places and at others similarly circumstanced, the air was stagnant during the period between August 25 and September 11, and was, besides, stagnant on all the 65 days noted as calm, between July 1 and September 11, at the more elevated and healthy stations.

Humidity of the Atmosphere.

Tables XXI. to XXIX. give all the information I have been able to collect upon the humidity of the air: from the observations contained in them, it appears that there was one-twentieth part less water in the air than the average for these months; and in Table XXIX., showing the weight of a cubic foot of air, it would seem that the air was more dense than usual, as the mean weight of a cubic foot of air was 2 grains above the average.

Thunder Storms.

There were but few thunder storms from July to the end of the year. The following are all the instances of electrical disturbances in the atmosphere noted about the Metropolis:—Thunder storms on July 9, 30, and August 3; thunder heard on July 4, 10, 31, August 2, 3, 17, and 19; and lightning seen on July 24, 25, and August 28. There was no instance of thunder or lightning about the Metropolis during the months of September, October, November, and December; in fact, no great electrical disturbance took place from the time of the first outbreak of Cholera in July, and during the continuance of

the disease. Hail was noted on one day only within the same interval of time, viz. on October 23.

So far, therefore, as the electrical observations indicate, in connexion with the much less than the usual number of electrical disturbances, it would seem that there has been a general deficiency in the tension of the common positive electricity prevalent during the period.

Electricity of the Atmosphere.

Table XXXVII. and remarks following contain all my collected information upon the electricity of the atmosphere during the prevalence of Cholera. No observations were made till the disease was at its height; at this time the electricity was positive but weak, and continued so till the end of September. Positive electricity was generally present, with tension somewhat greater than in September, indeed, always, except when rain was falling, in the months of October, November, and December, at stations of moderate elevation. Common atmospheric positive electricity has therefore been as prevalent as usual.

At stations situated nearly on a level with the river Thames, the electricity was generally weaker than at stations of higher elevation, and was more frequently negative.

I much regret that the electrometer observations began too late to afford any decided results. They would, however, seem to show that a deficiency of electricity prevailed during the time when the disease was at its height, and that at low stations, as compared with the higher, a deficiency was likewise to be observed.

Ozone.

By reference to Table XXXVIII. and the remarks following, it will be seen that no ozone was detected at any station near the river, excepting at Battersea and Millbank, where a little was recorded, but at stations of high elevation it was of general occurrence. This may be accounted for by the great amount of organic matter in the atmosphere in low districts, especially in those situated on a level with the Thames. These stations are also distinguished by a stagnancy of the atmosphere, and it remains to be proved whether the total defect of ozone at all the river-side stations is caused by the presence of large quantities of organic matter, decomposed by ozone, itself being simultaneously destroyed; or whether it is owing to the small amount of ozone contained in a small volume of air, which, to obtain a perceptible elimination of iodine, should pass the test papers in larger quantities; the latter supposition, however, is not supported by the observations taken at places where ozone was generally noticed, as at times the paper was less discoloured during the day than during the calm hours of the night.

Upon this subject Dr. Moffatt, in a recent letter addressed to me, says:—

" With regard to the absence of ozone in low places, and places " where the air is stagnant, I must say that my opinion on this point

" still oscillates, and I am as undecided to-day respecting its absence " under these conditions as I was five years ago. There is no doubt " that a test paper is much sooner tinged in a current of ozoniferous " air, then it is in a calm of the same air; the reason of this is obvious " enough. Ozone, however, is often detected during calms; so it " cannot be owing to the want of currents of air above. The only " time when calms give anything like the amount of colouration pro- " duced by a strong south or south-west current, is when they are " accompanied by continued falls of snow. During such falls I " have seen both Schonbein's and my own papers coloured as high as " 10; this I have attributed to the snow flakes bringing down the " ozone from the cirriferous and ozoniferous regions of the atmo- " sphere. Often during calms cirri are observed hovering in the " higher strata, and then there is no ozone; but when the cirri " come down to the earth's surface in the shape of snow, they bring " the ozoniferous air with them. Again at these times a calm may " prevail, and ozone will be detected without a fall of snow; but " when this is the case, the cirri will be seen moving from S. or " S.W. to N. cr N.E., and the ozone in the calm merely precedes " the setting in of a south current, if the barometer reading is " decreasing, and a thaw will soon commence, or if a north current " of the reading increases, in which case the fresh will continue.

" So much for the cause of the absence and presence of ozone " during proper calms; I will now speak of the absence of ozone " in stagnant air. I must first say that I have not the least doubt " that if snow fell in considerable quantity during any calm, that is " to say, if the upper strata of air came to the earth's surface, ozone " would be always detected. The want of ozone in stagnant air " may be accounted for in this way. Ozone is no doubt absorbed " by surrounding objects, or dissipated in some way or other by local " influences, and if the supply, either laterally by current, or from " above by downward motion, be not so rapid as the absorption or " dissipation, it must be in smaller quantities in places where atmo- " spheric currents slowly penetrate, than in localities freely exposed; " or it may not be in appreciable quantities. I am inclined to " believe that fresh and new surfaces destroy ozone. I have " observed that test papers have remained for weeks in a new ozone " test box, without colouration, which papers in an adjacent box were " indicating 3, 6, or 8 for the day. This discrepancy I attributed to " the newly wrought wood. It has been said that ozone is destroyed " by the action of the gases produced during the decomposition of " animal and vegetable offal, and at one time I was inclined to " believe that the outbreaks of Cholera in the neighbourhood of " newly cleaned pits, manure heaps, cesspools, and the like, was the " result of the removal of ozone. Experiment, however, does not " support anything of the kind. I have often placed test papers in a " position exposed to the action of decaying matter, and I have never " seen any difference between them and others placed beyond its " influence. The absence of ozone in low lying localities, where " Cholera has been the most prevalent and fatal, tends to prove that " ozone is a purifying agent."

Ozone papers were freely distributed in the Cholera wards of St. Mary's Hospital; a trace only of discolouration was observed on September 17, 18, and 27, rather more on September 21, 22, and 30; but no trace was noticed at any other time.

Test papers were placed in the different wards of Camberwell workhouse, in the Cholera decks of the Bacchante, and over each deck of the Dreadnought hospital ship, in many instances in close vicinity to the patients, under the direction of Dr. Rooke, and no trace of discolouration was detected in a single instance in any of these situations. In fact, with the exception of the few cases noted at St. Mary's Hospital, every test paper has remained colourless which has been placed in stagnant air, whether enclosed or not.

Haze, fog, mist, were singly or together prevalent, in July, on the 11th, 21st, 25th, 26th, 29th, and in August on the 13th, 16th, 17th, 25th, 26th, 28th, 29th, and 31st. The beginning of September was ushered in with a dense blue mist; in the second week of this month the disease was at its height, and the blue mist was exchanged for a thick atmosphere of fog, which continued with little intermission to the end of the month, at low places prevailing both day and night; the only days exempt were those of the 16th, 17th, and 20th. During all this time the distant country was misty, objects at moderate distances were indistinct, and the sunshine was pale and watery; occasionally, however, the atmosphere was translucent, and at times, in London, the churches and buildings were defined with a remarkable clearness I have seldom witnessed. At the low-lying places the veil of fog and mist might be said never during the whole of September to have been dispersed.

The same kind of weather continued in October, and mist, fog, or haze in or about London was recorded on the 1st, 2d, 3d, 4th, 9th, 10th, 12th, 13th, 14th, 15th, 16th, 18th, 20th, 21st, 23d, 24th, 25th, 26th, 27th, 28th, 31st, or 19 days in November; and on 21 days in December similar notes were made.

Rain.

Tables XXXIX. to XLIII. show that there was a deficiency of rain in every month of the year, except in May and December. Table XXXIX. and remarks following show that from July 1 to November 25, in all 136 days, not a drop of moisture fell on 93 days, and that the amount on 25 other days was very small, so that but little moisture fell on 118 days, including the outbreak, rise, and decline of Cholera. From August 24 to September 12 no rain at all fell, a period, it must be remembered, when the disease was at its worst. Rain to the depth of 0·4 inch fell in the week ending September 16. The rain-fall for the year was deficient by one-fourth of its average.

Drought.

A drought was felt in different parts of the country; the springs were low. The Rev. J. Slatter reports those about Oxford to be

7 feet below their ordinary level. Wells were generally low; many about the country were dried up, and the opportunity was taken very generally of clearing ponds and wells of long accumulated sediment.

I have now to the utmost of my means discussed the meteorological conditions of the period under the influence of Cholera. The results derived from the discussion are as decided, and perhaps more so, than might have been expected from an investigation the first of its kind ever instituted.

In the advent of another visitation of Cholera, a similarly conducted inquiry would tend to prove much which now is either matter of conjecture, or may be, of mere coincidence. With the view of discovering whether any similarity exists between the meteorology of the period just discussed and that of former years when Cholera was prevalent, I have instituted a brief meteorological inquiry with the years 1849 and 1832.

Atmospheric Phenomena in relation to Cholera in the Metropolitan Districts in the Years 1848 *and* 1849.

In the week ending October 7, 1848, there were 13 deaths from Cholera; this number increased to 65 and 62 in the weeks ending November 4 and 11 respectively, declined to 20 in the week ending December 2, and averaged 36 weekly from October 1 to the end of the year.

The weather during this period was variable, and the changes of temperature were frequent. The month of November was cold; but those of October and December were warm; the fall of rain was about its average. The amount of electricity in the atmosphere was small, many days together passing without the instruments at Greenwich being at all affected.

The direction of the wind—

From	October 1 to 11	- -	was	S.W.
„	October 11 to 20	- -	„	N.
„	October 20 to 31	- -	„	S.
„	November 1 to 7	- -	„	S.W. and N.W.
„	November 7 to 15	- -	„	N.
„	November 16 to December 9	-	„	S.W.
„	December 9 to 15	- -	„	S.
„	December 11 to 31	- -	„	N.N.E.

and the air was generally in motion.

LONDO

M CHOLERA AND

AL DAILY METEOR ARRHŒA

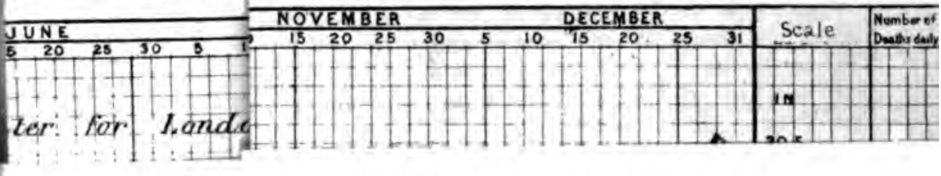


TABLE LIX.—Meteorological Table for the Year 1849.

1849. — Months.	Reading of Barometer corrected to 32° Fahr. and reduced to the Level of the Sea.	Difference from Average, Table IV.	Mean Temperature of Air.	Difference from Average, Table IX.	Mean of Highest Readings by Day.	Mean of Lowest Readings by Night.	Mean daily Range of Temperature.	Difference from Average, Table XVII.	Amount of Rain.	Difference from Average, Table XLII.	Amount of Cloud.
	in.	in.	°	°	°	°	°	°	in.	in.	
January - - -	29·949	+ ·041	40·1	+ 1·8	45·2	35·7	9·5	+ 1·3	1·6	— 0·5	7·7
February - -	30·284	+ ·362	43·2	+ 4·4	49·4	36·5	12·9	+ 2·4	2·2	+ 0·7	6·2
March - - -	30·093	+ ·137	42·5	+ 0·7	50·1	36·3	13·8	+ 0·4	0·5	— 0·9	7·3
April - - -	29·695	— ·197	43·2	— 3·3	52·5	36·5	16·0	— 0·9	2·2	+ 0·6	7·1
May - - -	29·944	— ·015	54·0	+ 0·6	63·8	46·7	17·1	— 2·0	3·9	+ 1·8	7·7
June - - -	30·046	+ ·085	57·9	— 1·4	69·1	48·5	20·6	+ 0·8	0·2	— 1·5	6·2
July - - -	29·967	+ ·004	62·1	+ 0·3	74·2	51·6	22·6	+ 5·1	2·9	+ 0·3	5·1
August - - -	30·019	+ ·061	62·9	+ 1·8	74·2	54·0	20·2	— 2·2	0·5	— 2·2	7·1
September - -	29·945	— ·060	58·8	+ 2·0	68·7	51·2	17·5	+ 0·2	3·3	+ 1·1	6·9
October - - -	29·922	+ ·083	51·1	+ 1·4	59·2	44·1	15·1	+ 1·5	2·7	— 0·3	6·5
November - -	29·921	+ ·023	44·1	— 0·2	49·8	38·1	11·7	+ 1·0	1·5	— 0·9	6·9
December - -	29·973	— ·037	39·1	— 1·3	43·2	34·1	9·1	+ 0·1	2·4	+ 1·0	7·1
Means - - -	29·980	+ ·041	49·9	+ 0·6	58·3	42·8	15·5	+ 0·6	Sum. 23·9	Sum. — 0·6	6·8

TABLE LX.—The PROGRESS of the EPIDEMIC in the Year 1849 is shown by the following TABLE, containing the NUMBER of DEATHS from CHOLERA registered in each WEEK.

1849. Week ending	Number of Deaths.	1849. Week ending	Number of Deaths.	1849. Week ending	Number of Deaths.
January 6	61	May 5	4	September 1	1,663
13	94	12	3	8	2,026
20	62	19	1	15	1,682
27	45	26	5	22	839
February 3	37	June 2	9	29	434
10	55	9	22	October 6	288
17	49	16	42	13	110
24	40	23	49	20	41
March 3	35	30	124	27	25
10	15	July 7	152	November 3	11
17	9	14	339	10	6
24	10	21	678	17	8
31	4	28	783	24	2
April 7	5	August 4	926	December 1	1
14	2	11	823	8	0
21	1	18	1,230	15	1
28	1	25	1,272	22	1
				29	0

In this year as in 1854, the greatest mortality took place about the beginning of September, but was more fatal in the early months of the year. In the week ending January 6, the number of deaths was 61, and on the following week as many as 94. The epidemic subsided at the end of March. In April and May the mortality was small. The disease broke out again in June, and in the week ending June 30 rose to 124. This high rate of increase continued till the disease attained its maximum 2,026 in the week ending September 8. The next week it began rapidly to decline, and decreased to 839 in the week ending September 22, and to 25 in the week ending October 27; after November 24 but few cases occurred.

The pressure of the atmosphere was above its average in January, and in February was remarkable. The average reading of the barometer from February 1st to the 18th, was 30·56 inches at the level of the sea; on the 11th, the reading was as great as 30·91 inches, a reading likely to occur but once in 30 years. The pressure continued high till about the middle of March. The mortality from Cholera had decreased from 94 in the second week of January, to 37 in the week ending February 3; had increased in the following week, and afterwards declined to 15 in the second week in March. The pressure was below its average from the middle of March, in April, and May, during the subsidence of the disease. In June the disease again broke out, and the pressure was again high, and remained high generally till September 8. The change of readings in August was small. On September 1 it was 29·67 inches, increased slowly till the 7th, when it was 30·22 inches, and turned

to decrease on the 8th. The mortality from June increased to its maximum 2,026 in the week ending September 8. The reading of the barometer declined rapidly on the 9th and 10th; was 29·2 inches almost without variation on the 11th, and still further decreased to 29·05 inches on the 12th; it then increased to 30·56 inches by the 19th, and decreased to 29·78 inches by the 27th; the disease declining rapidly. The pressure of the atmosphere was below its average in September and December, and above in October and November.

Temperature of the Air.

Till the disease declined in the middle of March the temperature was high, with the exception of the first seven days in the year; from January 8 to March 17 the average daily excess of temperature was 6°; within this period the excess exceeded 12° on three days, 13° on 2 days, and 14° on 2 days. From March 18 to June 30 the temperature was low, averaging a defect of 3° daily, which shows the temperature to have been low during the subsidence of the disease. From July 1 to July 17 it was 3° in excess; from July 18 to August 5 was 2° in defect; from August 6 to August 12 was 6° in excess: a few days of rather cold weather followed; from August 20 toSeptember 10 the temperature was in excess, averaging 4° daily, and this period was distinguished by a thick and stagnant atmosphere, the weather, for the most part, being close and oppressive. During this time the epidemic increased to its maximum, after which it rapidly and continuously declined. The temperature was for a few days together above, and a few days together below its average, till November 14, after which it was chiefly in defect to the end of the year.

Direction of the Wind.

	January, February, and March	chiefly	S.W.
	April, May, and June	„	N.E.
From	July 1 to July 8		S.W. and N.N.
„	July 10 to July 16		N.E.
„	July 17 to July 31		S.W.
„	August 1 to August 12		almost calm.
„	August 12 to August 17		S.W.
„	August 18 to August 31		N.W.
„	September 1 to September 10		Calm.
„	September 10 to September 16		S.W.
„	September 17 to September 30		N. and N.E.
„	October 1 to October 16		N.E.
„	October 17 to November 18		S.W.
„	November 19 to November 30		N.E.
„	December 1 to December 14		N.E. and S.E.
„	December 15 to December 31		S.W. and N.W.

From August 1 to 12 the air was almost calm; from the 12th to the 16th it moved rather quickly, but from the 17th to the end of the month it was frequently calm.

At the beginning of August the sky was frequently cloudy, but at times was clear. During the latter part of the month it was nearly always overcast, and the atmosphere was thick and hazy; at times so thick as to cause a great gloom, London being obscured by a dense fog-like mist, which overhung the city and rendered it invisible from Greenwich. Rain fell on 3 days only, to the amount of 0·4 inch of water.

From September 1 to 10 the air was calm; on September 11 and 12 the whole mass of air at all places was in motion, and the hills at Highgate and Hampstead were seen from Greenwich. The epidemic at this time was at its height, but soon after rapidly declined. From the 15th of September the air was in gentle motion.

During the months of August and September the motion of the air was about one half its usual amount; but this remark is applicable only at places of considerable elevation. At low places the motion was much less, and at many times it occurred that a strong wind was blowing on Blackheath, when at the same time not the slightest movement of the air was perceptible near the Thames: this was particularly the case from August 19 to 24, on the 29th, and from September 1 to 10.

During the outbreak at the beginning of the year the direction of the wind was chiefly S.W., and during its subsidence was mostly N.E. For some time before, and when the mortality was at its height, the air was in a stagnant state at all low places, particularly near the river Thames. The disease began to decline on the whole mass of air becoming in motion.

The temperature of the Thames water attained to 60° on May 24, and declined below this reading on September 14. On June 5 and 6, it was 66°, declined to 61° by the 12th, increased to 62° on the 21st, and to 69° about the middle of July; declined to 62° by the middle of August; increased to 65° by the beginning of September, and declined to 60° by the 13th. It was shortly after the temperature of the water had attained to 60° that the disease broke out a second time, and only declined when the temperature of the water descended below this reading.

TABLE LXI.—Showing the Electricity during the Year 1849.

Days of the Month. 1849.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	0	strong P.N.	0	No observations.	strong P.	mod. P.	0	strong P.	weak P.	strong P.	0	strong P.
2	0	0	0		0	strong P.	0	var. P.	0	strong P.	weak P.	0
3	0	mod. P.	strong P.		strong P.	0	0	strong P.	var. P.	strong P.	0	0
4	weak N.	mod. P.	mod. P.		strong P.	strong P.	0	var. P.	var. P.	strong P.	0	0
5	active P.	mod. P.	mod. P.		strong P.	strong P.	mod. P.	weak P.	var. P.	weak P.	strong P.	strong N.
6	weak P.	0	mod. P.		0	0	mod. P.	strong P.	0	strong P.	strong P.	mod. P.
7	mod. P.	mod. P.	0		0	0	0	strong P.	0	0	0	0
8	strong P.	weak P.	mod. P.		0	var. P.	0	0	strong P.	mod. P.	0	strong P.
9	strong P.	mod. P.	0		0	0	0	weak P.	var. P.	strong P.	0	strong P.
10	0	0	mod. P.		0	0	0	var. P.	mod. P.	strong P.	0	mod. P.
11	0	0	mod. P.		0	0	0	weak P.	weak P.	weak P.	0	weak P.
12	strong P.	active P.	weak P.	0	0	0	0	0	var. P.	mod. P.	0	mod. P.
13	0	active P.	0	strong N.	0	strong P.	0	0	weak P.	strong P.	0	mod. P.
14	0	active P.	strong P.	mod. P.	0	var. P.	0	weak P.	var. P.	mod. P.	0	0
15	mod. P.	0	strong P.	var. P.	0	strong P.	0	0	strong P.	strong P.	0	0
16	0	active P.	mod. P.	mod. P.	0	0	0	0	0	var. P.	0	0
17	0	0	0	0	0	0	0	strong N.P.	var. P.	0	0	0
18	0	0	0	0	strong N.	weak P.	0	strong P.	0	0	0	0
19	0	0	0	active N.	0	0	active N.	strong P.	var. P.	0	0	0
20	var. P.	0	0	strong P.	0	mod. P.	strong N.P.	0	strong P.	var. P.	0	0
21	0	0	0	strong P.	0	0	0	strong P.	0	0	0	0
22	strong P.N.	0	0	0	0	var. P.	0	mod. P.	var. P.	0	0	0
23	0	0	weak P.	0	0	strong P.	0	strong P.	0	var. P.	0	0
24	strong P.	strong N.	0	0	strong P.	mod. P.	strong P.N.	var. P.	strong P.	0	var. P.	active P.
25	0	strong P.N.	No observations.	weak P.	0	mod. N.P.	strong N.	mod. P.	var. P.	active N.	strong P.	strong P.
26	strong P.	strong P.		0	0	var. P.	strong P.N.	mod. P.	strong P.	0	strong P.	0
27	v. active P.N.	strong P.		mod. P.	0	var. P.	0	0	var. P.	0	var. P.	0
28	0	0		mod. P.N.	strong P.	strong P.	weak P.	weak P.	weak P.	0	mod. P.	0
29	0			strong P.	0	0	var. P.	0	0	0	0	weak P.
30	0			var. P.	0	0	weak P.	strong P.	0	0	0	0
31	var. P.				0		var. P.	var. P.		0		0

Fog, haze, and mist were not particularly noted till the month of August; they were frequent in August and September, and were noticed on fifty-three days in the quarter ending December 31.

The electricity of the atmosphere was occasionally strong, but for the most part it was weak, and the instruments were unaffected. It was nearly always positive. Thunder storms were rare: they were noticed on July 19, 20, and 26 only. Sheet lightning was seen on August 7, 11, and 20.

This closes my investigation into the meteorology of the year 1849, which exhibits an outline of facts very similar to that of 1854.

Atmospheric Phenomena in relation to Cholera in the Metropolitan Districts in the Year 1832.

My discussion of 1832 will be yet more brief, as my data is comparatively meagre, and the exact progress of the disease is not recorded. The office of the Registrar General has since been founded.

TABLE LXII.—Meteorological Table for the Year 1832.

1832. — Months.	Reading of Barometer corrected to 32° Fahr. and reduced to the Level of the Sea.	Difference from Average, Table IV.	Mean Temperature of Air.	Difference from Average, Table IX.	Mean of Highest Readings by Day.	Mean of Lowest Readings by Night.	Mean daily Range of Temperature.	Difference from Average, Table XVII.	Amount of Rain.	Difference from Average, Table XLII.	Amount of Cloud.
	in.	in.	°	°	°	°	°	°	in.	in.	
January - - -	30·051	+ ·143	37·3	− 1·0	40·8	34·5	6·3	− 1·9	1·2	− 1·0	6·7
February - - -	30·138	+ ·216	36·9	− 1·9	42·6	34·7	7·9	− 2·6	0·0	− 1·5	5·5
March - - -	29·965	+ ·009	40·5	− 1·3	47·7	36·9	10·8	− 3·4	1·4	0·0	6·2
April - - -	30·046	+ ·154	47·2	+ 0·7	56·4	42·0	14·4	− 2·5	0·4	− 1·2	4·7
May - - -	29·982	+ ·023	51·5	− 1·9	61·6	46·3	15·3	− 3·8	1·5	− 0·5	6·0
June - - -	29·893	− ·068	59·2	− 0·1	69·5	55·2	14·3	− 5·5	3·3	+ 1·7	6·8
July - - -	30·122	+ ·159	61·2	− 0·6	71·2	56·1	15·1	− 2·4	0·7	− 1·9	5·7
August - - -	29·899	− ·059	61·0	− 0·1	71·3	56·8	14·5	− 3·5	3·4	+ 0·7	6·5
September - -	30·154	+ ·149	56·6	− 0·2	66·2	51·8	14·4	− 2·9	0·4	− 1·8	4·7
October - - -	30·110	+ ·271	51·2	+ 1·5	57·9	48·4	9·5	− 4·1	2·5	− 0·5	6·5
November - -	29·912	+ ·014	43·7	− 0·6	49·0	41·9	7·1	− 3·6	1·7	− 0·7	6·6
December - -	30·025	+ ·015	42·4	+ 2·0	47·0	39·0	8·0	− 1·0	1·1	− 0·3	6·5
Means - -	30·025	+ ·085	49·1	− 0·3	56·8	45·3	11·5	− 3·2	Sum. 17·6	Sum. − 7·0	6·0

The total number of deaths in London from Cholera in 1832 was 5,275, which is less by far than the aggregate number in the two succeeding visitations. The progress of the epidemic was as follows:—It broke out in the middle of February, and by the middle of May the deaths numbered 994. It then subsided, and broke out again in June, was most fatal in August, and by the end of October the number of deaths amounted to 4,266. It then declined suddenly, and in November and December the number of deaths was 15 only.

Pressure of the Atmosphere.

On January 1st the reading of the barometer was 29·40 inches, which increased to 30·36 inches by the 15th, and was generally above 30 inches, except on the 26th, till the end of the month. The reading declined rapidly on February 1, to 29·26 inches on the 2d, but was as high as 30·60 inches by the 10th. The disease seems at this time to have increased in intensity at places where it had previously been, and to have broken out at fresh places. The pressure continued high for the most part throughout the month. In March the readings varied from 29·40 inches, on the 7th to 30·40 inches on the 10th. On April 4 the reading was 30·64 inches, which was the highest in the year. On April 30 it was 29·36 inches, and was the lowest in the month. In the early part of May the readings were high: the extremes were 30·45 inches on the 10th, and 29·53 inches on the 31st. The pressure was high in March, April, and the first half of May, and the disease declined to its minimum about the middle of May. In June the readings were low at the beginning of the month, and high towards the end; the extremes were 29·54 inches on the 6th, and 30·50 inches on the 30th. The disease re-appeared this month. In July the changes of reading were small; the extremes were 29·78 inches on 7th, and 30·47 inches on the 15th. The pressure for the whole month was in excess. In August the reading on the 2d was 29·89 inches, increased to 30·50 inches on the 11th, decreased to 29·83 inches on the 19th, increased to 30·13 inches on the 20th, decreased to 29·20 inches by the 22d, increased to 30·13 inches on the 24th, and decreased to 21·29 inches by the 28th, which was the lowest reading in the year. The disease at this time was at its height and its turning to decline seems in some measure connected with the low reading of the barometer at the end of the month. On September 4, the reading was 30·34 inches; it decreased to 29·84 inches by the 10th; increased to 30·40 inches by the 12th, and was generally about 30 inches during the remainder of the month. The readings in October were high, but there was nothing remarkable in those of November and December. The pressure of the atmosphere was above its average in every month of the year, excepting June and August.

Temperature of the Air.

The temperature was below its average in every month, excepting in April, October, and December, when it was slightly in excess. The spring was cold and vegetation backward, and it was noticed that no spring-like growing weather took place till towards the end

of May. The summer was cold, and the temperature never reached so high as 80°. The diurnal range of temperature was small in every month.

Clouds.—The sky was for the most part covered with cloud, and there were very few cloudless days in the year; at the same time the number of wholly overcast days was much less than usual. The clearest periods were in April and September, when the sky was less than one-half covered with cloud; the amount of cloud in all the remaining months covered something less than three-fourths of the whole sky.

Rain.—The fall for the year was 17·6 inches, being in deficit one-fourth of the average.

Fog was noticed on January 20, 21; February 22, 23, 25, 27; March 11; October 22; and December 27 and 28.

Haze was recorded on March 27, September 4, and October 20.

Thunder and *lightning* were noted on June 7, August 2; on this day there was a heavy thunder storm; August 3, November 29, and December 2.

Hail fell on June 7 and December 2.

Direction and estimated Strength of the Wind.

Jan. 1 to Jan. 10, N.E.	Estimated strength	0·6	Calm on	3	days.
Jan. 10 to Feb. 10, S.W.	„	1·0	„	7	„
Feb. 11 to Feb. 29, N.E.	„	0·5	„	8	„
Mar. 1 to Mar. 7, S.	„	1·8	„	1	„
Mar. 8 to Mar. 11, N.E.	„	0·4	„	2	„
Mar. 12 to Mar. 27, S.W.	„	1·7	„	0	„
Mar. 29 to Apr. 14, N.E.	„	1·3	„	1	„
Apr. 16 to Apr. 21, S.W.	„	1·4	„	0	„
Apr. 25 to Apr. 30, N.E.	„	1·4	„	0	„
May 1 to June 6, N.E. and N.W. chiefly		0·9	„	7	„
June 6 to June 25, S.W. chiefly	„	1·0	„	3	„
June 26 to July 2, N.	„	0·5	„	1	„
July 3 to July 17, W.S.W.,	„	1·2	„	0	„
July 18 to Aug. 2, N.	„	1·1	„	0	„
Aug. 3 to Sept. 3, S.W.	„	1·1	„	3	„
Sept. 4 to Sept. 7, N.E.	„	0·6	„	1	„
Sept. 8 to Sept. 19, S.W.	„	1·1	„	1	„
Sept. 20 to Sept. 24, S.E. and N.E.	„	0·7	„	1	„
Sept. 25 to Sept. 29, calm	„	0·0	„	4	„
Sept. 30 to Oct. 18, W.S.W.	„	2·0	„	0	„
Oct. 19 to Oct. 28, N.E.	„	0·8	„	1	„
Oct. 29 to Nov. 4, S.W.	„	1·5	„	0	„
Nov. 5 to Nov. 8, N.	„	1·6	„	0	„
Nov. 9 to Nov. 27, S.E.	„	0·9	„	3	„
Nov. 28 to Dec. 27, S.W.	„	1·2	„	6	„
Dec. 27 to Dec. 31, N.E. and S.E.	„	0·9	„	0	„

The direction of the wind during the year was mostly N.E. and S.W. The numbers showing the estimated strength can be considered only as relative; from them it seems that the air was seldom in a calm state; the longest period noted as calm was from September 25 to September 29, and was most freely in motion during the first 18 days in October. During the year 53 days were noticed as being calm.

Conclusion.

The meteorological phenomena in relation to Cholera in the year 1832 furnish us with the means of comparison with the phenomena of 1849 and 1854, in relation to the general pressure of the atmosphere, temperature of the air, direction of the wind, fall of rain, clearness of sky, and frequency of electrical disturbances, but do not furnish other particulars.

Those of 1849 and 1854 furnish the means of satisfactorily comparing the general character of the two seasons.

No observations were made at the central Metropolitan stations in the years 1832 and 1849, and the meteorological phenomena of the outlying stations only admit of strict comparison.

In the year 1832 the barometer reading was high; that of the thermometer was low; and rain was deficient one-fourth of its average in the year. In the summer, when the disease was raging for the first time in England, the barometer was high; the temperature below the average; the quantity of rain small; the direction of the wind N.E. and S.W.; the air not in much motion; the sky partially overcast, and there was a seeming deficiency of electricity.

In the year 1849 the pressure of the atmosphere was great; the temperature high; the sky overcast; the direction of the wind N.E. and S.W.; the atmosphere misty and thick; the velocity of the air less than one-half its average. When the epidemic was at its height a calm prevailed, with a misty thick atmosphere at all places, which was sensibly more dense and torpid in low places; the weather was dull, thick, and oppressive; no rain; temperature of the Thames above 60°; weak positive electricity; no electrical disturbances.

In the year 1854 the pressure of the atmosphere was great; the temperature generally high; sky overcast; direction of the wind N.E. and S.W., and the velocity of the air was less by one-half than its average for some time before; and at the time of the greatest mortality from Cholera, the barometer reading was remarkably high, and the temperature above its average; a thick atmosphere, though at times clear, everywhere prevailed; weak positive electricity; no rain. In low places a dense mist and stagnant air, with a temperature in excess; temperature of the Thames water high; a high night London temperature; a small daily range; an absence of ozone, and no electricity.

The three epidemics were attended with a particular state of atmosphere, characterized by a prevalent mist, thin in high places, dense in low. During the height of the epidemic, in all cases, the reading of the barometer was remarkably high, and the atmosphere thick. In 1849 and 1854, the temperature was above its average, and a total absence of rain, and a stillness of air amounting almost to calm, accompanied the progress of the disease on each occasion. In places near the river, the night temperatures were high, with small diurnal range, a dense torpid mist, and air charged with the many impurities arising from the exhalations of the river and adjoining marshes, a deficiency of electricity, and, as shown in 1854, a total absence of

ozone, most probably destroyed by the decomposition of the organic matter with which the air in these situations is strongly charged.

In 1849 and 1854, the first decline of the disease was marked by a decrease in the readings of the barometer, and in the temperature of air and water; the air, which previously for a long time had continued calm, was succeeded by a strong S.W. wind, which soon dissipated the former stagnant and poisonous atmosphere. In both periods at the end of September, the temperature of the Thames fell below 60°, but in 1854 the barometer again increased, the air became again stagnant, and the decline of the disease was considerably checked. It continued, however, gradually to subside, although the months of November and December were nearly as misty as that of September. By the close of the year diarrhœa and Cholera had subsided, but a high rate of mortality still continued.

The co-existence of Cholera with coincident meteorological phenomena is, to say the least of it, remarkable, so is the stagnant atmosphere prevalent during the time of Cholera in each of the three periods, and which would seem to be a necessary condition to the activity of the disease.

The inimical nature of the influence it exercises upon the public health, I regard as intimately connected with the state of the water and the marshes, which in the preceding pages are shown to be large evaporating surfaces for every description of poisonous exhalations. Impure water and impure air are inseparable, for the impurities of the former will be concentrated into the surrounding atmosphere, and there remain, unless rapidly dispersed under favourable atmospheric conditions.

The agency of the river in fostering diseases is confirmed by the history of Cholera just traced, and which we find to have been most fatal in low situations, and in London in those places on the south side of the Thames which afford an undisturbed lodgment for the reception of the air charged with the poisonous elements from evaporation and exhalation. The effect of a gentle wind is to float this atmosphere to enclosed spots where its malignity becomes concentrated.

This closes a discussion I have endeavoured to make as elaborate as the means and time at my disposal have permitted.

I cannot consider the birth of Cholera attributable solely to atmospheric influences; at the same time, the preceding pages have shown, beyond a doubt, the activity of London climate in accelerating the disease, thereby showing its progress to be intimately connected with meteorological influences.

What other causes are combined with those of meteorology to aid the progress of this formidable epidemic, have yet to be ascertained.

Just as this Report was printed, I received a copy of the Report of the Sanitary Commission on epidemic yellow fever in New Orleans. That *part on the relation of* meteorological phenomena to cholera

and yellow fever, written by Dr. Edward H. Barton, exhibits a rare example of patient research; he having discussed with minuteness all the epidemics of cholera and yellow fever in relation to the meteorology of the district as far back as the meteorological observations are trustworthy, and he points out the meteorological condition during the rise and progress of each epidemic. His results, in many instances, are in close accordance with those I have stated in my Report.

No. II.

Report on the Examination of certain Atmospheres during the Epidemic of Cholera. By Dr. R. D. Thomson.

The facts with which we are acquainted in reference to the condition of the atmosphere, indicate that its main constituents, oxygen and nitrogen, are very stable in their proportions. The mean of experiments made on the composition of the air in various parts of the globe shows that the amount of oxygen by measurement is approximately 21 per cent., and that of the nitrogen 79; but in certain cases within the tropics, the conditions of which have not yet been thoroughly investigated, the quantity of oxygen falls to 20·3 per cent. The influence of this diminution would be slightly to lower the weight of a given bulk of air, a result the reverse of what it is understood was observed during the first introduction of cholera into this country (Prout). No physiological facts seem to indicate that such a slight departure from the normal state of the air would be attended in the human organization with a disease possessing a regular type, nor even would such a consequence be liable to occur during greater irregularities in the atmospheric equilibrium in this direction. The agency of carbonic acid in inducing disease can scarcely be quoted as likely to occur on a great scale in nature, since the diffusive power of this and other gases, so sagaciously discovered by Priestley, and applied by him to explain the respiratory process, always tends to preclude its concentration, except under a limited number of peculiar circumstances. The accumulation of ammonia, another recognized normal constituent of atmospheric air, from the insignificance of its possible amount, could scarcely be quoted as a likely source of disease, however much it might be valued as an indication of the collateral existence of other bodies of organic origin in the air. If this reasoning be admitted, we should be compelled to look for the source of endemic diseases to the vapour of the atmosphere or to organic bodies, either disseminated through the air by the agency of heat or evaporation from inorganic or organic matter placed on the earth's surface. Intermittent fever or ague is one of those diseases which has been thoroughly ascertained to be endemic, and to be dependent on terrestrial causes of a peculiar character. Whether the cause be the nature of the atmosphere in which the human system is immersed or the introduction of a poison into the circulation, is a question open to discussion. The fact that removal from the marshy or intermittent atmosphere to an elevated and dry mountain summit or table land obviates or speedily terminates the morbid accession, affords support to the view which would ascribe the occurrence of the disease to immersion in an atmosphere nearly saturated with vapour, and the consequent inter-

ference with the necessary evaporating processes over the surface of the healthy body, and even possibly with the exhaling powers of the pulmonary organs. But this aspect of the case seems to obtain less support from the circumstance that relapses are liable to supervene when the patient, even at long intervals of time, is placed in atmospheres where different conditions prevail to those which originally gave origin to the disease. Of 22 cases of ague which were under my charge at Whampoa, in China, in a pre-eminently intermittent atmosphere, situated in extensive rice grounds which are flooded by the tide, relapses occurred in five instances. Three of these relapses came under treatment in the China sea; but three other persons were attacked on the same sea with ague, who had escaped all its symptoms in the malarious atmosphere of Whampoa. Another relapse took place in the Indian ocean, and the fifth relapse occurred in Table Bay, with a temperature of 71° and dry weather. But the most striking fact was that three persons who had enjoyed good health in China were seized with ague, one the second day after losing sight of the Chinese continent, and two others in the China and Java sea, while another instance occurred off the Cape of Good Hope. On scrutinizing carefully these facts, it appears that least difficulty is experienced in explaining them by the supposition that a poison had been absorbed into the system and had incubated and developed itself into disease in such constitutions as were predisposed to a morbid state. But there was no disposition manifested towards the propagation of the disease from one individual to another. I have not observed a similar character to prevail as to the protracted period of incubation in the remittent fever of China, but I think it probable that similar cases may have occurred. It is well known that the African remittent fever has its symptoms developed frequently at intervals of two or three weeks after exposure to the causes which seem to produce it (Captain Owen's Survey of the East Coast of Africa); and there is a sufficient analogy between all these types of fever to warrant the suspicion, at least, that they are regulated by analogous laws.

Brought by such a process of reasoning to the inference that the production of endemic diseases, as illustrated in the case of intermittent fever, is most easily explained by the hypothesis that a poison is introduced into the system by absorption from a malarious atmosphere, it remains to be considered whether the poison is disseminated in the air in the gaseous, vaporific, or mechanically diffused condition. There are no facts with which we are acquainted having any tendency to indicate that the respiration of vapours is capable of producing a disease characterized by a regular type, or that gases act physiologically otherwise than as dilutents of oxygen, or as simple poisons. Neither is the evolution of gases alone from organic matter calculated to induce such diseases of endemic nature as are recognized by a regular sequence of symptoms. For example, the extrication of sulphuretted hydrogen, one of the most poisonous gases with which we are acquainted, or of phosphuretted hydrogen and resulting poisonous phosphorous and mild phosphoric acids, would not be fol-

lowed in a marshy district by ague, so far at least as our knowledge of the physiological action of these bodies enables us to predicate. The products of putrefaction of an elastic gaseous nature are not the chemical substances most to be dreaded in the production of disease, as is demonstrated by the result of such action on the poison of cow pox or small pox, or of dissection wounds. It is the fresh, undecomposed matter which is alone capable of propagating the noxious influences so familiar in the instances to which allusion has been made; and any agent which interferes with the integrity of the morbific molecule destroys its capability of inducing a regular disease.

It was in consequence of the result of this mode of reasoning that I have long been of opinion that the cause of endemic diseases, if disseminated in the air, must exist there, either in the condition of solid particles, or in a state allied to the vaporific form. The practical bearing of this conclusion is, that we are not to expect any information respecting the morbid condition of the air from experiments on a small scale upon the chemical constitution of the normal gases in any given atmosphere, or even on the minute traces of abnormal gases which may be detected by the most delicate appliances of science. The fact, which seems to be well authenticated (Boussingault), that the inhabitants of South America are enabled in some localities to withstand the attacks of endemic diseases by mechanical applications, such as veils placed before the organs of respiration, so as to sift the air from morbid solid particles, supports the view of the organic nature of malarious poison. Absorbent porous bodies used instead of veils, such as charcoal, have been long disused in manufactories from their power of condensing gases, which are replaced by the inspired air in its passage through them, and are thereby carried into the circulation. Proceeding on the idea involved in this view of the nature of the cause of endemic and epidemic diseases in 1849–50, at the former invasion of cholera, I subjected a a large quantity of external atmospheric air in an infected district to chemical investigation with the view of condensing any vapour, or of detaining solid particles which might be disseminated through the air. The result was entirely negative. (See *Chemical Researches on the Nature and Cause of Cholera,—Transactions of the Royal Medical and Chirurgical Society*, vol. xxxiii. 1850.)

When the Board of Health, during the occurrence of the epidemic in 1854, gave its sanction to investigations bearing upon the discovery of a tangible cause of the disease, I began to follow out on a more extended scale the experiments which I had executed in 1849–50. For this purpose, as before, the system of aspiration was adopted for drawing a quantity of air through tubes, and subjecting it to various condensing influences. A large air-tight cistern, of the capacity of 16 cubic feet, was constructed of wood and lined with zinc. A pipe connected with a water cistern conveyed water to an aperture in its top, while a tap at the bottom allowed the cistern to be emptied. The cistern was fitted with a graduated glass gauge tube at the side, which indicated the amount of water and air contained in it. An aperture in the top of the cistern was supplied with a flexible tube, and was

connected with Woulfe's bottles and tubes, containing fluids through which the air was drawn from an infected atmosphere by the aspirating power of the water contained in the cistern as soon as it was allowed to flow out by the lower tap. From the interest taken by the authorities of St. Thomas's Hospital in all that concerns the progress of medical science,* I was enabled to erect this apparatus adjoining the wards set apart for the reception of cholera patients, and without moving the cumbrous mechanism could thus examine the expired air of the cholera ward under various circumstances together with the external air, and the air of other atmospheres. The ward whose atmosphere was specially examined was the casualty ward of the hospital occupied by female patients attacked with the epidemic, but the atmosphere communicated with an adjoining ward filled with male cholera patients. The meteorological conditions which prevailed during the period when a series of experiments was carried on have been distributed under five different heads or tables. From the dates appended to these tables it will be observed that the apparatus was kept in action during 87 days, or, with short intervals caused sometimes by its slight derangement, the experiments extended with little intermission from the 13th of September to the 23d of December inclusive. The total quantity of air subjected to examination under different conditions during this period approached 1,800 cubic feet, or precisely 1,794·6 cubic feet.

First Experiment.

Examination of the Atmosphere of the Cholera Ward when filled with Patients. (Table I. Plate I.)

In this experiment glass tubes carefully washed with distilled water and dried were conducted from the centre of the ward along the roof of the ward, and terminated by dipping into distilled water in a Woulfe's bottle. A second Woulfe's bottle was connected with the first bottle by a tube dipping likewise into distilled water. Beyond these was an U tube, which was filled with pumice stone moistened with sulphuric acid. The U tube was connected with the aspirating cistern by means of a flexible vulcanized caoutchouc tube. The cistern being filled with water, and its interior placed freely in communication with the system of tubes and bottles, on the tap at the bottom of the cistern being opened, the cistern began to be emptied, the water running into a sink placed immediately beneath, while its place was taken by the air of the ward, which traversed the distilled water in the Woulfe's bottles and the sulphuric acid in the U tube. The distilled water was carefully prepared, and just before being introduced into the Woulfe's bottles it was rapidly boiled. A portion of the same water in a stoppered bottle was placed beside the apparatus, and was carefully examined microscopically after the completion of the experiment, and compared with the distilled water through which the atmosphere of the ward had passed. The air was allowed to stream through the water and

* The drawings of the objects condensed from the several atmospheres have been most skilfully and truthfully executed by Mr. Tuffen West.

AIR OF CHOLERA WARD. PL. I.

Oct. 5th to Oct. 21st 1854.

The figures refer to the number of dia.

a. *Blue and red cotton.*
b. *Hair.*
c. *Wool.*
d. *Fungi.*
e. *Sporules.*
f. *Fungi in very Early stage.*
g. *Vibriones.*
h. *Fungi in advanced stage.*
i. *Particles of Silica and Dirt.*

sulphuric acid during four days, until 98·6 cubic feet had traversed the tubes. On the second day after the commencement of the experiment it became very evident that organic matter was carried along with the air in its transit through the tubes, as the sulphuric acid in the U tube became distinctly dark coloured, and as the process proceeded, this charring effect augmented until it assumed a colour analogous to that familiar to chemists in the case of Nordhausen acid. The distilled water subjected to the action of the air was found to give a strongly acid reaction with litmus paper. On the addition of nitrate of baryta a copious precipitate of sulphate of baryta fell, which was insoluble in hydrochloric acid. The source of this acid was no doubt the product of the combustion of the sulphur of coal used for heating the ward, and probably also of the gas employed for lighting the ward. The sulphur of the pyrites of the coal and the traces of bisulphide of carbon frequently found in gas, yield, when subjected to combustion, sulphurous acid, which again, when brought in contact with water and air, speedily takes up more oxygen, and is converted into sulphuric acid. No chlorine nor other mineral acid could be detected in the distilled water. During the course of the experiment delicate filaments became distinctly visible in the distilled water, which were easily recognized without the application of any magnifying power; and after the cessation of the experiment they increased in magnitude, thus giving strong evidence of their vital vegetable character. It deserves notice that the greatest amount of vegetation and of mechanical matter visible to the eye existed in the second Woulfe's bottle and not in the first, which shows the difficulty of detaining such light bodies by the resistance of water alone. Plate 1 exhibits a view of the objects visible at one time under the field of the microscope, with the exception of *h*, which has been introduced subsequently, to exhibit a more advanced stage of the vegetation of *d*. The coloured fibres in the drawing are good examples of filaments of cotton, which are characterised by their ribbon-shaped flatness and sharp edge, while they are tubular, and somewhat tend to a spiral curvature. Two filaments of this description are visible in the drawing marked *a*: the larger painted with royal blue, or steamed Prussian blue, and the smaller of a pink tint, derived probably from madder. These objects are magnified 150 diameters. The figures attached to the other objects indicate the number of diameters to which they have been magnified. The object in view in thus presenting them was to afford the advantage of a prospect of everything existing under the object glass of the microscope at the same time. To form a correct notion of the nature of the drawing, we have only to consider the slide containing the figures represented to remain stationary under the microscope, and that some of the smaller objects have been increased in size merely by altering the powers as was found to be requisite. The most striking objects in the drawing next to the cotton fibres are filaments of hair, *b*, and probably wool, *c*. On the latter objects it is by no means easy to give a decided opinion; but their characters, perhaps, approach more nearly to those of a worn portion of wool than to any other object likely to be present in such a locality. Grouped around and

intermixed with the cotton filaments, may be observed fine confervoid looking fungi, *d*, tubular, with their tubes occupied at intervals with granular or vesicular bodies; *f* represents these fungi in a very early condition of their growth, and *h* one which has been subsequently introduced into the drawing, and which I endeavoured to bring towards maturity by growing in shallow water. During the limited period at my disposal, I did not, however, observe any tendency towards the formation of fructification. Sporules (*e*) were abundantly distributed over various portions of the field of vision, and in one specimen examined, two potato starch granules could be distinctly detected. In various points small masses of siliceous matter, traces of soot and dust were visible, which seem to have been entangled in the web of fungoid mycelium, which rapidly increased in volume by continuous growth; vibriones (*g*) were also readily recognized in numerous parts of the field, which were characterised by great activity and rapidity of transit from one point to another. Some of these were of considerable length, but were too minute to enable their anatomy to be made out even by a power of a thousand diameters. It is not easy to decide as to the nature of the dottings and minute lines which can be traced along the margins of the larger objects, although their forms do not present much dissimilarity to those of vibriones (although no movements were recognized). They also resemble what has been observed among the products of fructification of certain classes of lichens. From this experiment we learn that considerable quantities of matter are diffused in an inhabited apartment through the most distant portion of the enclosed atmosphere from that in which the patients breathe and are immersed, since the tube employed in the trial detailed opened near the ceiling of the room, and yet constituted the medium by which fragments of cotton fibre detached from the garments of the female inmates were conveyed. Besides these mechanical impurities, the source of which can be so readily detected, we find likewise the sporules of vegetables and likewise the ova or germs of animal existence. This view seems more consonant with the circumstances than the idea that the plants and animals themselves were actually dispersed through the atmosphere, although there appears nothing paradoxical in the anticipation that if particles of dress are so volatile they may be accompanied by portions of vegetation which may also have been previously deposited on the same articles of clothing.

Second Experiment.

Examination of the Atmosphere of the Cholera Ward when half filled with Patients. (Table II. Plate II.)

As I had resolved to prosecute the examination of the air of the cholera ward continuously, and the first experiment having terminated when cholera was somewhat on the wane, the second experiment was entered upon when the amount of patients did not exceed half of the previous number. New bottles having been charged with carefully prepared distilled water, the apparatus was arranged so that the air should traverse two Woulfe's bottles, containing

AIR OF CHOLERA WARD;
(Partially Empty.)
Sept.r 20th to Oct.r 4th 1854.

The figures refer to the number of diameters.

a. *Organic matter.*	f. *Linen?*	k. *Sporules.*
b. *Vegetable Epiderm.*	g. *Vegetable Hairs.*	l. *Spore case of Oidium Tuckeri?*
c. *Vegetable Cellular Tissue.*	h. *Sponge Spicula?*	m. *Sporangia?*
d. *Fragments of Wood.*	i. *Fungi very minute.*	n. *Stipes of Botrytis?*
e. *Cotton.*	j. *Fragment of spiral vessel.*	o. *Epithelium.*

p. *Oil globules.* r. *Silica and Dirt.*

distilled water, and a U tube, which was surrounded with ice and was placed between the Woulfe's bottles and the aspirating cistern. Table II. affords a view of the conditions of the atmosphere during the experiment, with the amount of air passed. The air examined amounted to 240 cubic feet, and was allowed to pass through the tubes during 13 days. The quantity of air transmitted during that period was 240 cubic feet, and the proportion passed daily was pretty equally distributed over the fortnight during which the experiment lasted. The water in all the bottles was found to be strongly acid at the conclusion of the trial, and to give a copious precipitate with nitrate of baryta, indicative of the presence of free sulphuric acid. The second Woulfe's bottle contained a larger amount of visible matter detained than the first bottle, while in the U tube, which had been surrounded by the ice, a very considerable quantity of organic and other forms could even be detected to a certain extent by the eye. The amount of water in the U tube, which must have been conveyed from the distilled water in the Woulfe's bottles by the transmitted air, and condensed by the cooling application, amounted to above a fluid ounce, since the tube was carefully cleaned and dried out at the commencement of the experiment. I find it noted that the U tube contained more mechanical matter diffused through the water condensed in it than appeared to exist in either of the Woulfe's bottles. Plate 2d represents an accurate delineation of the forms visible under the field of the microscope at the same time, the powers employed varying from 100 to 200 diameters, as represented in the attached figures. The forms are somewhat different from those in the first plate, for while fragments of higher organic tissues predominate the comparative absence of fungi is sufficiently striking. *a* appears to be organic matter, but of too indefinite an aspect to enable an opinion to be risked of its origin; *b* is obviously vegetable epidermis, and may have been detached from an onion used as food; *c* is vegetable cellular tissue; *d* is a fragment of wood; *e* a filament of cotton dress dyed with madder and Prussian blue; *f* bears much resemblance to a filament of linen; *g* seems to be vegetable hairs (wheat?), approximating in some respects to those of tobacco leaf, but this suggestion occurred from the circumstance that tobacco was smoked in the adjoining ward, and on one occasion at least, in the ward itself; *h*, from its stationary character, it was concluded, was a sponge spicula, although in some respects it might be mistaken for a higher order of organism; *i*, minute fungi, are remarkably scanty in amount compared with their prevalence in the products of the first experiment. Sporules, *k*, however, were distributed scantily over the field, and a spore case, *m*, apparently could be detected, while *l* bore a strong resemblance to the spore case of *Oidium Tuckeri*. A fragment of spiral vessel, *j*, occurs on the right of the plate, similar objects being visible in the epidermic membrane *b*. The form represented at *n* has much similarity to the stipes of Botrytis; *o* is obviously a portion of epithelium, which has floated up after detachment from the inmates of the ward; *p* bears a strong resemblance to oil globules. Throughout the field dark masses are noticeable which seem to be particles

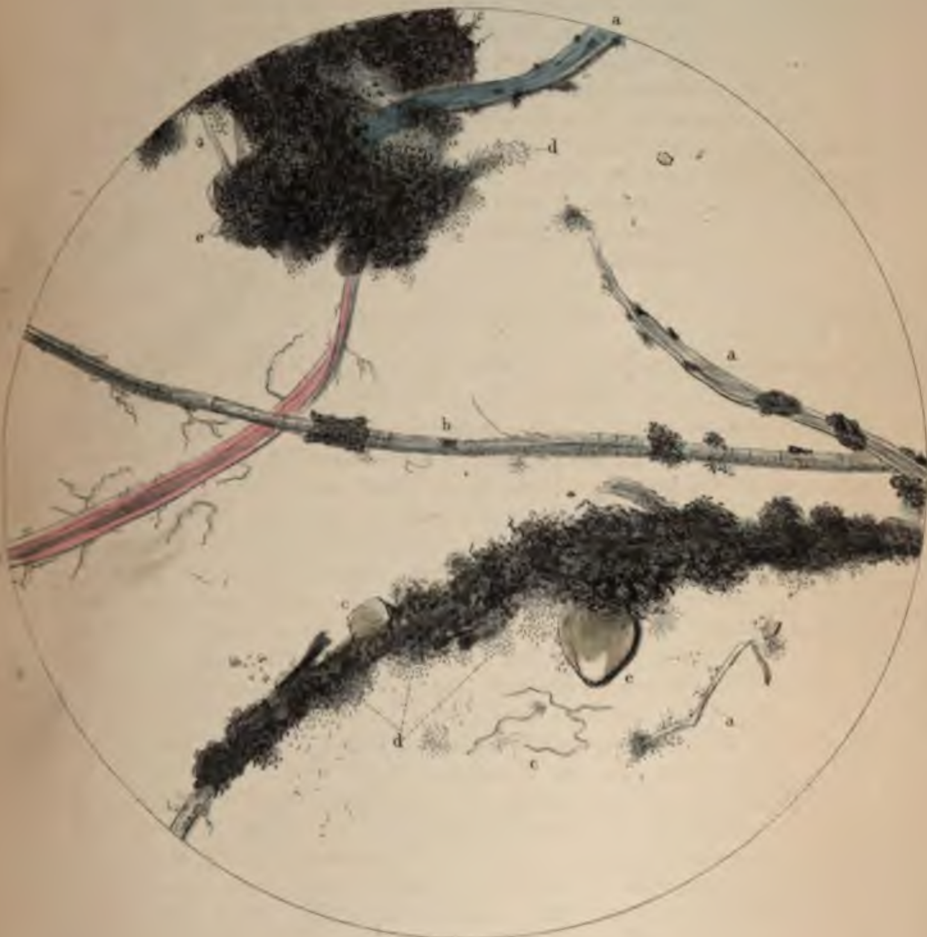
of siliceous matter and various impurities which are capable of being detected in all atmospheres where disturbance of dust is liable to take place. The present experiment differs in a remarkable degree from the results of the previous trial, by the circumstance that no animal matter was capable of being detected in the second case, while in the former instance a considerable amount of vitality was clearly discernible. But after careful examination repeatedly resumed, no trace of vibriones was visible in the matter detained in the second air examined, notwithstanding the much larger proportion of atmosphere conveyed through the tubes. We observe also among the present products epithelial matters from the human surfaces, and are thus presented with ample evidence of one of the consequences of a too condensed population by the possible thorough contamination of the air which must be used for respiration with not only the impure exhaled gases, but likewise even with solid particles of human origin, detached and diffused through the atmosphere in which the inmates of houses are immersed.

Third Experiment.

Examination of the Air of the Ward after the Removal of all Patients. (Table III. Plate III.)

In this trial the apparatus was preserved in the same state of arrangement as in the second experiment, the bottles, however, and tubes, as in the previous cases, being quite new, and having never been employed for chemical purposes previously; they were carefully washed out and dried. Two Woulfe's bottles occupied the same position as previously, and a U tube surrounded by a freezing mixture connected the last bottle with the aspirating cistern by means of a vulcanized caoutchouc tube. This experiment lasted for fifteen days, from the 5th to the 21st of October inclusive, and comprehended the examination of 304 cubic feet of ward atmosphere; (Table III.) The patients had ceased to enter the ward in consequence of the decrease of the epidemic, and the only disturbance which could occur in the atmosphere must have been due to the operations of cleaning and airing the apartment. The distilled water through which the air passed was, as on the preceding instances, possessed of an acid reaction due to the presence of sulphuric acid. The visible amount of detained matters was more minute than previously, and it was this circumstance that led to the aspiration of more air in this than in the foregoing trials. But, although no patients existed as inmates of the ward, there was a free communication with the adjoining ward, which was occupied by males affected with the epidemic, where fires and gas were in an active state during the twenty-four hours. This is sufficient to account for the large amount of lamp black (plate 3 *e*,) which occupies such a prominent place in the drawing. The circumstance that the ward had been occupied by females, and had undergone the process of sweeping and washing, explains the occurrence as in the former experiments of the blue and red filaments of cotton, fig. *a*, and of what corresponds best with wool, *b*. But notwithstanding the amount of air which traversed

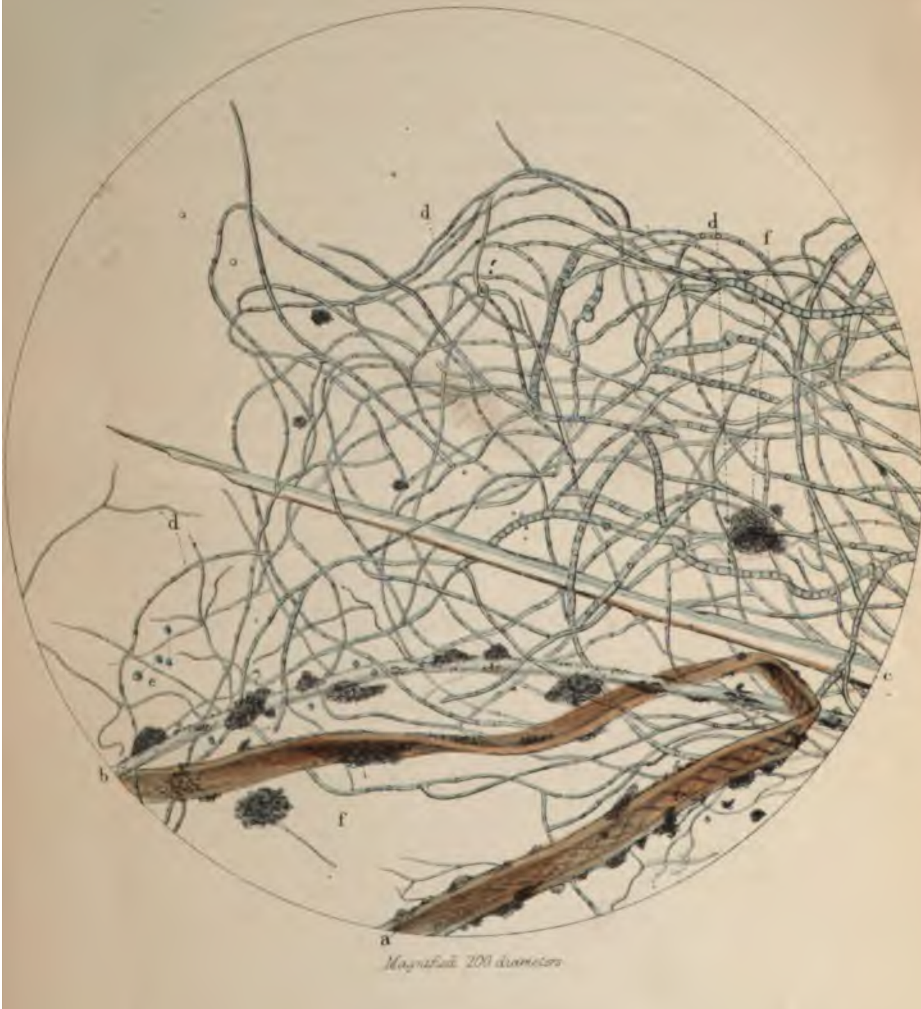
AIR OF EMPTY CHOLERA WARD;
Sept^{r} 13th to Sept^{r} 19th 1854.



Magnified 200 diameters.

a Cotton fibres. b *Wool* c *Fungus.*
d e *Carbonaceous & Silicious Particles.*

EXTERNAL ATMOSPHERE:
Oct.r 21.st to Nov.r 16.th 1854.



Magnified 200 diameters

a *Cotton fibre?*
b *Wool?*
c *Crystalline body.*
d *Fungus in various stages.*
e *Sporules.*
f *Carbonaceous matter.*

the tubes, it cannot fail to attract attention, that but a minute fragment of fungus (*c*) remains, while it is still more worthy of remark, that sporules seem to have entirely ceased to pervade the same atmosphere, which during the period when the ward was filled with inmates, was characterised by abundance of these vegetable forms. The siliceous particles mixed with the fuliginous matter (*c*) constitute a considerable portion of what is often termed dust, and what is so familiar when a strong draught is made to permeate an apartment, or the deposit on the objects in a room is disturbed. The objectionable character of an atmosphere contaminated by dust and smoky particles is not, however, diminished by its familiarity, since pathology points out to us the results of such noxious influences in the densely black charged lungs of the weaver and collier; the former with the lamp black from the murky atmosphere of his oil lamp, and the latter from a similar cause, with the superadded auxiliary of the finely diffused coal dust of his subterranean cell. These, and the facts which have already emphatically forced themselves on our attention during the discussion of the present examinations of air, show us that when we can detect such impurities in a comparatively well ventilated apartment, we may not be surprised if the air of densely crowded dwellings, allowed to stagnate as in some of the cellars in the Soho district which I visited, packed with six to twelve inmates in a cube of 12 feet, should induce disease and early death. Whether we admit or not with the Stoics of old "that every man is rich who has the free enjoyment of earth and air," certain it is that the human being must be reckoned poor indeed who is continually immersed in an impure atmosphere.

Fourth Experiment.

Examination of the External Atmosphere.

(Table IV. Plate IV.)

In this research the same form of apparatus was employed, and the same mode of arrangement as has been already described, with the modification in the adjustment that the tubes leading from the ward were dispensed with, and their place supplied by a flexible caoutchouc tube, which, protruding into the external air through a window, was carried along the wall of the building a few feet, and was then made to project. The experiment lasted for 21 days from the 21st October to the 16th of November (Table IV.), during which 560 cubic feet of air streamed through the apparatus. It was long before any visible appearance of mechanical deposit was exhibited. But as soon as any object was discernible a comparatively rapid augmentation in volume ensued, affording strong evidence of the development of vegetation so beautifully represented in Plate 4. The tardiness in the growth of the fungus may perhaps receive some explanation from the fact which is very obvious in all the drawings, viz., the presence of some foreign matter, as wool or cotton. Until some such bodies were detained by the water, it may be easily understood that no very striking object could be discerned by the eye. As soon, however, as a filament of cotton gained access to the fluid, it would exercise

an obvious tendency to aggregate any other extraneous bodies which might be diffused through the water, and by affording a point of attachment to sporules would enable them to remain in a certain degree of comparative rest, and thus enable the incipient stage of germination to proceed. For, on the cessation of the streaming of the gas through the water, and afterwards, when the fluid was placed in perfect stillness, even in the absence of light, vegetation advanced with great rapidity. Plate 4 exhibits a filament of cotton (*a*) of a brown tinge, magnified, as well as the other objects, to the extent of 200 diameters. Interlaced with it is what agrees most nearly with a filament of worn wool (*b*), and a crystalline body (*c*) somewhat resembling in some respects a sponge spicula. A fungus (*d*) in various stages of its growth occupies the prominent portion of the field, and sporules (*e*) similar to those probably from which the plant originally sprung are observable in different parts of the drawing. Throughout the vegetable masses dark fuliginous matter is distributed, derived from the soot of the chimnies or from the gas burnt in the wards. The proximity of the source of the air to the building renders it possible that the vegetation may have proceeded from the same source as in the preceding experiments, and this could only have been decided by experiments conducted in different free atmospheres at a distance and in approximation to inhabited neighbourhoods. As during the present investigation every day was occupied in the examination of different atmospheres for comparative purposes, more prolonged researches must be deferred to another opportunity. The present results seem to hold out encouragement that, by various improvements and expansions in the mode of experimenting which have suggested themselves in the course of the collection of the facts observed in this report, some important additional light may be thrown on the subject of impure atmospheres, and on the best means of removing the extraneous matters which constitute their contamination, either by ventilation conjoined with chemical applications or by mechanical or other auxiliary means. In common with all the experiments, except the first, when the ward was filled with diseased patients, no trace of animal movement could be detected, and although the acid reaction of all the solutions was equally distinct, no vibriones were visible except on the first trial, although in that instance the amount of air subjected to examination was greatly inferior to that employed in all the subsequent examples.

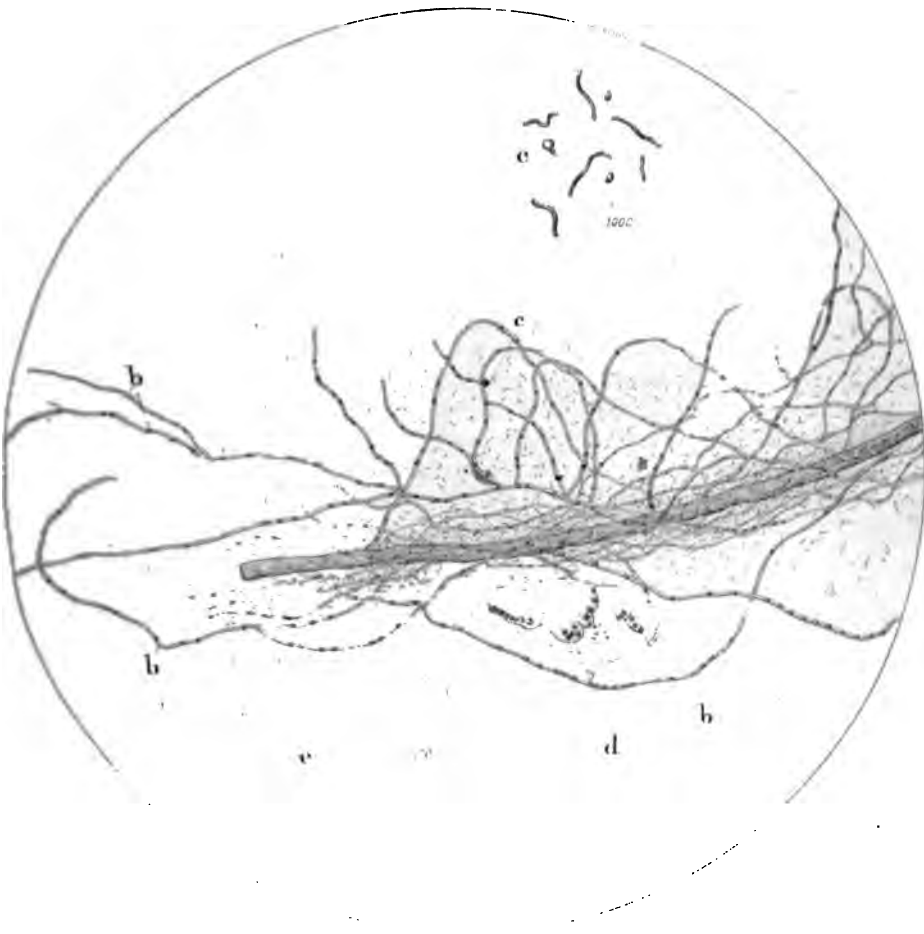
Fifth Experiment.

Examination of the Atmosphere of a Sewer. (Table V. Plate V.)

There can be no doubt in the mind of any one who has been in the habit of directing his observation to the condition of the soil in a city, that there exists under the dwellings of the inhabitants, and under the streets, sources of impurity which may well induce us to ascertain if some amelioration of the present circumstances cannot be adopted. To test the conditions generated by the fluids thrown off from city habitations, the present experiment was made. The most accessible means of chemically examining the question,

SEWER ATMOSPHERE.

Nov. 22nd to Decr. 23rd 1854.



a. *Fragment of Wool.* b. *Fungus.* c. *Sporules.*
d. *Spore cases.* e. *Vibriones*

seemed to be to subject to scrutiny the atmosphere in immediate contact with these fluids themselves. For this purpose a new gas pipe was conducted from the atmosphere of the sewer, and connected with the apparatus by means of a flexible tube. The extremity of the gas pipe dipped downwards to within a foot of the surface of the contents of the sewer. The Woulfe's bottles were arranged as in the previous experiments with a U tube, the air having been allowed previously to stream through the flexible tube alone in connexion with the cistern to displace the common air contained in the apparatus. The experiment was carried on during 27 days, from the 22nd of November to the 23d of December inclusive, and during that period, 592 cubic feet passed through the tubes. (Table V.) The amount of mechanical matter detained was less than in any of the preceding experiments, but still it was visible to the eye, and when allowed to deposit in an inverted conical vessel, the sediment could be, although with some difficulty, from its levity, collected for the purposes of microscopical examination. The distilled water, which in all the previous investigations had been rendered strongly acid, yielded on the present occasion the most unequivocal evidence of powerful alkaline reaction, due to ammonia, which is an usual result of the decomposition of such animal and nitrogenous vegetable substances as occur in the sewer waters. Plate 5 exhibits a delineation of the matters detained in the transmission of the sewer atmosphere through the distilled water. Prominently, as in the previous drawings, a large filament (*a*), probably of wool, appears to act as a nucleus or means of aggregating the rest of the sediment. Beautifully convoluted round it we find branches of the elegant mycelium of a fungus, which appears to be developing. Spore cases (*d*) are seen in the lower part of the drawing, while sporules (*c*) are scantily discernible. All these objects are magnified to the extent of 200 diameters. In the upper part of the plate we detect, in much larger quantity than in any of the previous trials, a nest of vibriones, magnified to 1,000 diameters, characterised by the most lively and active motion, traversing the field of the microscope with a great rapidity, propelled by their peculiar vermicular like action. Of a smaller size, but in great abundance, similar bodies may be noticed to the lower left of the drawing, and thickly stretched among the ramifications of the mycelium. These appeared strongly to assimilate to vibriones in their physical outline, but movements were not so visible, except in some cases to a limited extent. The peculiarity in the results obtained from the examination of a sewer atmosphere, affords a sufficient distinction to enable us to discriminate it from the air contained in wards, and in the free atmosphere; for while all the other atmospheres investigated have been highly acid, the air in the sewer has been strongly alkaline, and the amount of animal life in the sewer has been found greatly to predominate over that which has been detected in the atmospheres above ground. It is obvious, then, that, in addition to the noxious gases, such as sulphuretted hydrogen, carbonic acid, carburretted hydrogen, &c., which may be evolved in various proportions from the decomposing organic matters in the sewer fluids, there exist in the sewer

atmosphere living beings of vegetable and animal origin, or at least the sporules and germs of these organisms exist there. That analogous growths are capable of being propagated in the animal systems is well known. That the sources of the latter are extraneous, seems to receive conntenance from the interesting researches of my colleague, Mr. Rainey, in his investigations on the pathology of cholera. I refer to his report, which relates the fact of his having discovered an entozoon in the opening of the air passages, the analogues of which have hitherto only been found imbedded in the tissues of the human body, thus yielding evidence of the foreign origin of such animals. His observation, too, of the absence of growing fungi in solutions when the supernatent air has been filtered, but which under ordinary exposure to the atmosphere are covered with these vegetations, affords strong evidence of the distribution of such seeds in the air, and of their tendency to take root and grow in congenial soils. It seems scarcely necessary to observe that the probability of the air deriving any wholesome virtue from the presence of such vital powers distributed through it is highly improbable, while the possibility, on the contrary, of their presence being liable to be followed by noxious results to health appears self-evident. In the Soho districts I found great complaints widely distributed, of the nauseous and sickening odours emanating from the gratings placed over apertures communicating with the sewers, and although these smells might alone not be capable of engendering diseases of a characteristic type, they are not only calculated of themselves to prejudice health, but they are indications of the accompaniments of foreign organic beings, merely traces of which it is probable have yet been detected. The investigation having been made during the winter, when decomposition of organic matter is much checked, and when the diminished temperature is antagonistic of organic life, it would be necessary to conduct comparative trials in summer, before conclusions could be drawn as to the prevalence of such beings in any atmospheres. Simultaneous observations on the meteorological condition of the atmosphere are likewise of importance, as bearing on the powers in action on its mass, to obviate any stagnant tendency of the air and to prevent the accumulation of extraneous and morbid influences.

Summary.

From the results which have been obtained in the course of the present researches, the following deductions may be drawn:—

1. That in the atmosphere of a cholera ward, mechanical matters were diffused throughout the air derived from the inmates, that sporules of fungi and germs of vibriones, or vibriones themselves were obtained by filtration from the atmosphere—all of these bodies being adulterations, so to speak, of the pure oxygen and nitrogen, which alone constitute the wholesome predominating constituents of the elastic fluids destined for respiration.

2. That from a ward only partially filled with patients affected with cholera, substances were separated which were mechanically

dispersed to the very summit of the apartment, mixed with fungi or their sporules, while no vibriones, unless in the form of faint traces, could be detected.

3. That in the atmosphere of an empty ward, communicating however with a ward containing cholera patients, mechanical matters were obtained and traces of fungi, and perhaps of vibriones.

4. That in the external air adjacent to an hospital, substances mechanically distributed were likewise found, and sporules with fungi were also detected to a considerable extent, but no vibriones.

5. That in the atmosphere of a sewer, bodies were also found in mechanical diffusion associated with sporules, fungi, and vibriones.

6. That the air contained under the three first conditions from wards possessed an acid reaction, that the external atmosphere likewise indicated a similar chemical condition, and that the sewer atmosphere was alone alkaline.

7. That although animal and vegetable life seem unequivocally to be diffused through cholera atmospheres, it would be premature to infer a connexion between the disease and these organisms until comparative trials have been extensively made on other conditions of air; and that the present researches must be only considered as a single stone placed as a contribution towards the foundation of a larger structure.

ROBERT DUNDAS THOMSON, M.D.

St. Thomas's Hospital,
18th February 1855.

TABLES.

I.—First Experiment on Atmosphere of Cholera Ward when filled with Patients.

1854.			Air passed in Cubic Feet.	Barometer Corrected.	Dry.	Wet.	Maximum.	Minimum.	Wind. Direction	Wind. Force.
					°					
Sept.	Wed.	13	6	29·894	68.7	64·1	75·9	61·8	S.W.	Strong breeze.
„	Thurs.	14	42	29·742	65·1	59·2	69·9	59·9	S.W.	„
„	Fri.	15	16	29·943	65·0	59·3	68.2	54·3	W.S.W.	Gentle breeze.
„	Sat.	16	34·6	29·845	70·0	64·7	69·1	61·0	W.S.W.	Strong breeze.
„	Mon.	18		30·098	67·1	57·6	70·9	53·2	W.	„
„	Tues.	19		30·004	63·1	61·0	67·5	57·4	N.W.	„
			98·6							

II.—Second Experiment on Atmosphere of Cholera Ward when half filled with Patients.

Sept.	Wed.	20	16	29·882	69·7	63·5	68·2	57·3	W.	Strong breeze.
„	Thurs.	21	16	30.093	60·0	53·0	69·3	48·2	N.W	„
„	Fri.	22	16	30·327	51.2	48·1	61·6	45·1	N.W.	Gentle breeze.
„	Sat.	23	16	30·223	58·5	55·7	59·0	49·6	N.W.	„
„	Mon.	25	16	30.289	58·0	57·1	67·0	46·4	N.W.	Fresh breeze.
„	Tues.	26	16	30·361	57·1	52.3	56·8	46·4	W.	Gentle breeze.
„	Wed.	27	16	30·337	63·8	55·9	62·2	46·7	E.S.E.	„
„	Thurs.	28	16	30·142	64·1	54·8	66·0	48·6	S.E.	„
„	Fri.	29	16	30·131	56·8	53·9	65·6	45·7	W.S.W.	„
„	Sat.	30	16	30·185	54·3	52·4	60·6	46·5	S.W.	„
Oct.	Mon.	2	32	30·054	53·4	57·6	58·5	45·0	Calm.	
„	Tues.	3	32	29·771	59·9	56·5	60·8	48·1	W.N.W.	Fresh breeze.
„	Wed.	4	16	29·826	56·4	50·1	60·8	45·0	W.S.W	Gentle breeze.
Total cubic feet			240							

III.—Third Experiment on Atmosphere of Cholera Ward when empty.

Oct.	Thurs.	5	16	29·582	64·9	58·4	64·0	52·7	S.W.	Fresh breeze.
„	Fri.	6	16	29·527	56·4	54·8	67·5	53·9	E.	Gentle breeze.
„	Sat.	7	16	29·958	54·8	49·7	57·0	46·5	E.	Strong breeze.
„	Mon.	9	16	29·714	58·4	57·6	58·0	52·1	Calm.	
„	Tues.	10	16	30·046	59·4	56·6	61·2	50·4	W.	Gentle breeze.
„	Wed.	11	32	30·149	58·6	52·2	59·0	50·5	N.W.	Fresh breeze.
„	Thurs.	12	32	30·531	52·6	46·9	59·4	43·0	N.	Gentle breeze.
„	Fri.	13	32	30·448	46·4	44·8	59·9	37·0	W.	„
„	Sat.	14	16	30·309	51·9	50·2	52·0	43·4	W.	„
„	Mon.	16	16	29·996	50·8	46·2	53·3	43·1	N.N.E.	„
„	Tues.	17	16	29·360	50·1	47·4	52·5	38·5	E.	Fresh breeze.
„	Wed.	18	16	29·277	49·9	48·8	51·4	43·2	N.W.	Gentle breeze.
„	Thurs.	19	16	29·798	46·8	42·8	51·0	37·9	W.	„
„	Fri.	20	32	29·370	52·8	49·9	53.1	43·3	N.W.	„
„	Sat.	21	16	29·606	51·9	48·	53·0	43·2	N.W.	Fresh breeze.
Total cubic feet			304							

In these Tables the temperatures refer to the external atmosphere in the shade. During the period of experiment no ozone was detected.

IV.—Fourth Experiment on the Air of the External Atmosphere.

1854.			Air passed in Cubic Feet.	Barometer Corrected.	Dry.	Wet.	Maximum.	Minimum.	Wind.	
									Direction	Force.
Oct.	Sat.	21	16	29·606	51·9	48·0	53·0	43·2	N.W.	Fresh breeze.
„	Mon.	23	32	29·348	51·7	47·2	55·8	42·9	W.	„
„	Tues.	24	32	29·511	48·9	44·8	53·1	37·4	S.W.	„
„	Wed.	25	32	29·043	46·4	45·5	50·9	40·9	E.N.E.	„
„	Thurs.	26	32	29·746	45·4	43·1	47·4	36·3	W.N.W.	Gentle breeze.
„	Fri.	27	48	30·389	44·9	43·1	48·5	34·0	S.W.	„
„	Sat.	28	32	30·346	54·9	50·0	54·5	41·0	S.S.W.	Fresh breeze.
„	Mon.	30	32	30·192	57·9	54·1	54·0	44·1	S.W.	Gentle breeze.
Nov.	Wed.	1	32	30·423	49·8	48·5	63·7	44·6	N.	„
„	Thurs.	2	16	30·366	52·0	51·0	62·4	45·1	S.	„
„	Fri.	3	16	30·285	50·0	45·4	54·6	44·3	N.W.	Fresh breeze.
„	Sat.	4	32	30·226	46·8	44·2	50·6	38·3	N.	Gentle breeze.
„	Mon.	6	32	30·403	48·0	44·2	54·3	40·1	N.W.	„
„	Tues.	7	16	30·546	46·1	44·2	49·2	35·8	W.	„
„	Wed.	8	32	30·257	46·9	44·6	47·8	39·1	W.S.W.	Fresh breeze.
„	Thurs.	9	32	30·230	41·9	38·5	49·5	35·1	N.N E.	„
„	Sat.	11	32	30·095	47·1	45·5	49·5	36·5	N.	Gentle breeze.
„	Mon.	13	16	30·171	44·6	42·1	44·3	32·0	S.	„
„	Wed.	15	32	29·117	46·8	45·4	47·2	33·3	S.W.	„
„	Thurs.	16	16	29·041	48 4	47·2	48·0	40·2	E.S.E.	„
Total cubic feet			- 560							

V.—Fifth Experiment on the Atmosphere of a Sewer.

Nov.	Wed.	22	32	29·972	40·4	39·0	43·5	35·1	N.W.	Gentle breeze.
„	Thurs.	23	16	29·093	48·4	37·1	40·8	32·0	E.N.E.	„
„	Fri.	24	16	29·316	39·2	38·0	39·2	32·1	N.	„
„	Sat.	25	16	29·616	39·1	38·1	40·5	32·5	N.	„
„	Mon.	27	16	30·086	31·4	30·2	37·2	27·8	N.	„
„	Tues.	28	16	29·832	40·9	40·0	40·5	28 9	W.	Fresh breeze.
„	Wed.	29	16	29·033	47·1	44·1	47·0	37·6	W.	„
„	Thurs.	30	16	29·675	41·5	39·5	48·0	39·5	W.	Gentle breeze.
Dec.	Fri.	1	16	29°664	44·4	42·1	48·6	38·4	N.W.	Fresh breeze.
„	Sat.	2	16	30·009	43·8	39·6	45·8	35·6	N.W.	„
„	Mon.	4	16	30·170	47·1	43·3	48·6	41·3	W.	„
„	Tues.	5	16	29·597	50·1	47·5	50·2	46·0	W.	„
„	Wed.	6	32	29·607	43·6	40·4	51·2	35·6	S.W.	„
„	Thurs.	7	32	30·243	40·5	38·9	44·6	34·5	N.	„
„	Fri.	8	32	29·847	46·2	45·2	46·0	32·4	W.	„
„	Sat.	9	32	29·486	43·8	41·2	49·3	40·8	N.W.	„
„	Mon.	11	16	30·061	36·4	35·0	38·5	27·5	S.S.W.	Gentle breeze.
„	Tues.	12	16	30·161	40·1	38·4	44·6	35·2	W.S.W.	„
„	Wed.	13	32	30·249	44·2	42·2	45·6	35·2	W.S.W.	„
„	Thurs.	14	32	29·972	53·0	51·8	54·3	41·3	W.	Fresh breeze.
„	Fri.	15	32	29·977	52·9	49·1	55·4	48·3	W.	Strong breeze.
„	Sat.	16	16	29·850	45·9	43·1	54·6	43·8	N.W.	Fresh breeze.
„	Tues.	19	16	29·890	36·0	32·8	41·4	31·6	W.	Gentle breeze.
„	Wed.	20	32	29·533	43·1	42·5	43·4	32·7	N.N.W.	Strong breeze.
„	Thurs.	21	16	30·143	39·9	39·0	44·6	31·2	W.	Gentle breeze.
„	Fri.	22	16	29·855	52·1	51·0	53·4	36·2	W.N.W.	„
„	Sat.	23	32	29·944	45·5	43·0	54·0	40·8	W.	„
Total cubic feet			- 592							

No. III.

Report on the Microscopical Examination of certain Atmospheres, during the Epidemic of Cholera. By Mr. Rainey.

THE observations which will form the first part of this Report have an especial reference to the condition of the atmosphere in a Cholera district, both when Cholera was present, and after it had entirely left the neighbourhood. In the prosecution of these inquiries I have had the advantage of a series of very careful experiments, instituted and carried on at St. Thomas's Hospital, upon a very large scale, by Dr. Dundas Thomson, the Professor of Chemistry at this Hospital.

As Dr. Thomson's report will contain the details of these experiments, it will only be necessary for me to make such allusions to them as will be required to render my own observations intelligible. The immediate object of these experiments was to transmit the air of one of the Cholera wards at different periods through a small quantity of distilled water, in order that it might be determined by microscopic examinations whether the water thus treated contained any organic or inorganic bodies when Cholera prevailed which could not be found in it when the disease was absent. First, some of the distilled water through which the air of the Cholera ward had been transmitted, when the disease was at its height, was examined by the microscope with the best lenses, under the best illumination. This water contained a great variety of substances, some of which were alive, and evidently in an active state of growth: these were so apparent as to be visible to the naked eye. The other substances were not possessed of life, but were from the dust which had floated in the atmosphere of the ward. These latter consisted of minute hairs, of vegetable fibres of different kinds and colours, of starch granules, amorphous black carbonaceous matter, which were particles of smoke, and lastly of epithelial cells. With respect to the origin and presence of these substances in this water, little need be said, since it is at once obvious that, in the act of making the beds, and in that of dressing and undressing, numerous vegetable and animal fibres would be detached from the bed clothes, with particles of starch which had been employed for stiffening the patients' linen, and be wafted into the upper part of the air of the ward, and from thence be carried by the tubes connected with the apparatus into the distilled water, in which they would be detained. With these substances the epidermic scales in progress of desquamation from the surface of the body, when detached from it by the slighest friction, would, from their extreme lightness, readily ascend, and mingling with them in the atmosphere, form also a part of this heterogeneous compound. These contaminations being diffused through the whole of the air in the ward, would not only gain access to the parts of the apparatus destined to convey them into the fluid in the reservoirs, but they must with equal facility

find their way into the lungs of all who are obliged to breathe the same contaminated atmosphere. But it must be remarked that such impurities are not confined to the atmosphere of the wards of hospitals; they exist of course in the air of all apartments where persons sleep; their proportion to the quantity of pure air depending upon the number of persons in any one apartment, its size, the time they spend there, and also upon their general habits of personal cleanliness, or the neglect of it. These impurities are present also in the open air, especially in densely populated districts, where they will be mixed with gaseous contaminations of different kinds. As it respects the origin and presence of the living organic bodies before alluded to in the distilled water, some further observations are necessary. These bodies had the appearance of small flocculent masses in the fluid at the bottom of the vessel, visible to the naked eye. These were examined at the same time by Dr. Thomson and myself, and were found to consist of the mycelia of fungi, apparently in an active state of vegetation, mixed with the fibrous portion of the impurities before mentioned. By a most careful examination with the microscope, I could not discover any appreciable difference between these growths and the mycelia of fungi, which had formed in solutions of vegetable substance after exposure to the air where no Cholera was present. In this instance these fungi were associated with more or less extraneous vegetable fibres; but these I believe to be altogether unnecessary for the production of these bodies, as the mycelia of fungi are capable of developing themselves in fluids where no such extraneous matter is present. Besides the fungi, there were extremely minute, colourless, indistinctly beaded fibres, resembling in their general characters that form of vibrionia called "bacterium." These were so abundant as to cover some of the larger branching fibres of the mycelium to which they seemed to be attached. These bodies are so extremely minute that, under a magnifying power of 900 diameters, and good illumination, they do not present very definite structural characters. I do not recollect to have seen them on mycelia growing in astringent vegetable solutions prepared for the purpose of producing fungi.

After this another portion of distilled water, through which the atmospheric air of the same ward had been transmitted precisely in the same manner as before, though when the disease was very much on the decline, was submitted to microscopic examination. This water contained impurities attributable to dust, similar to those already particularized in the other water, also the same two living organic bodies, although the vibrio-like fibres were much less numerous than in the first experiment; however they were in sufficient quantity to remove all doubt as to their actual existence. These fibres, as also the mycelia found in this water, presented the same characters as those found in the first quantity.

Next a third portion of distilled water was treated precisely in the same manner as the other two, though after the Cholera had entirely left the district. This water, like the last, contained some foreign particles, attributable to dust, also the mycelia of fungi in considerable abundance, and apparently in an active state of vege-

tation, but I could not find any of the vibrio-like growths, although I examined this water with great care.

The next microscopic examinations which were instituted were made with the view of determining whether any organic bodies were present on the lining membrane of the air passages of those who had died from Cholera which were not to be found in the same situations in those who had died from other causes. The membrane covering the inferior vocal chords was considered to be the part most suitable for this examination, as it is difficult to imagine how organic bodies floating in the air, sufficient in quantity to destroy life on reaching the interior of the lungs, could all pass through so small an aperture as the rima glottides without leaving some trace behind on that membrane. This portion of the mucous membrane is also well adapted for such an examination, in consequence of its epithelium being squamous, and not ciliated, as in other parts of the air passages, and so transparent and simple in its character, that in case any extraneous bodies had been there arrested, they would be placed under circumstances the most favourable for their detection and minute inspection by the microscope. I accordingly examined the larynges of eleven persons who had died in the Cholera ward of this (St. Thomas's) Hospital. They were all well marked cases, and the examination of each was made as soon after death as circumstances would permit. The appearances were in all these cases moderately uniform. I could detect nothing like spores, or the mycelia of fungi, or the vibrio-like fibres in any one of them. Had these been present in the larynges of these individuals it would have enhanced the importance of the first experiments, but still their absence does not detract much from them, for it is far from certain that physiologists are yet able to recognise all the various forms in which these bodies do exist. The appearance which the mucous membrane presented in all these larynges when examined immediately after death were as follows:—The squamous epithelium in some parts was studded with patches, generally inclining to an oval form, of extremely minute dark points, producing an appearance resembling that which is frequently seen in animal matter just beginning to produce vibriones, in other parts the molecules composing these patches had a decided tendency to coalesce and form larger particles, presenting all the microscopic characters of minute masses of oil. The same part, when examined at a later period, that is, after two or three days, had undergone a considerable change; vibriones had formed in it in great abundance. They were in vigorous motion; at this time well-defined crystals of triple phosphate were deposited in considerable quantities, but still the patches of molecules were present, and had undergone no appreciable alteration. In order to determine how far the ap pearances just described might be considered as normal or abnormal, or whether they were confined to Cholera subjects or not, I examined the same part of the mucous membrane in an individual who had not had Cholera, but who died from the effects of an accident; and in making a careful comparison of the appearances in these cases, I could discover no difference by which I was enabled to distinguish one from another. The patches of molecules in the two states, as above noticed, were present in the latter case, differing in no

appreciable degree from those in the Cholera subjects. These appearances seem, therefore, to be natural, and due to a normal process of molecular disintegration which the epithelial scales are undergoing prior to their complete decay. This epithelium also, when examined after two days, was beset with vibrios, and deposited triple phosphate as in the Cholera cases. I have since examined other larynges of persons not affected with Cholera, which confirm the conclusion I had before arrived at, namely, that there is no appreciable difference in the mucous membrane covering the inferior vocal chords in persons who have died of Cholera from those who have died of other complaints.

I have examined the blood of several Cholera patients, in which there was nothing remarkable, unless it be the large quantity of triple phosphate which it deposited after standing a day or two. I have made also some examinations of the rice-water motions, but without being able to detect in them anything which had not been before noticed. The very early appearance of vibriones in these motions, even directly after they had been voided, seemed at first to be a remarkable circumstance; however, on examining the contents of the different divisions of the intestinal canal, as short a time as possible after death, before any signs of putrefaction were apparent, I also found them in the contents of all these parts in considerable abundance, and in active motion, even as high up in the intestine as the duodenum. Being desirous to ascertain whether these organisms existed only in the contents of the intestines of persons who had died of Cholera, I examined the contents of the intestinal canal of individuals, also as soon after death as practicable, who had died of other complaints, and I still found vibriones; so that it appears these bodies, existing in the secretions of the intestinal canal, do not form one of the peculiarities of Cholera.

George Rainey, M.R.C.S.,
Lecturer on Practical Anatomy, and Demonstrator of Microscopical Anatomy at St. Thomas's Hospital.

No. 40, Doddington Grove, Kennington Park,
January 1st, 1855.

No. IV.

Report on a Sanitary Inspection of the Golden-square District, by Dr. D. Fraser, Mr. Thomas Hughes, and Mr. J. M. Ludlow.

SIR,

PURSUANT to the instructions received from you, we have made a house-to-house inspection of that portion of the City of Westminster comprised in the Registrars' sub-districts of Berwick Street, and Golden Square, St. James, and St. Ann's, Soho, where Cholera has been most prevalent.

Our inspection has been guided chiefly by the paper of instructions issued by you to us on the 8th of September, which is embodied in this Report, and printed in Italics. That paper of Instructions begins as follows:—

Heads of Inquiry in the Districts of St. James, Westminster, which has suffered most from Cholera.

1*st.* *The inquiry to be a house-to-house inquiry, especially and primarily in the streets which have suffered most, and in regard to the houses in those streets which have had cases and deaths.*

2*d.* *The inquiry will resolve itself into the condition of the atmosphere before and at the beginning of the attack.*

(A.)—Structural peculiarities of the Streets as regards ventilation.

We have given the great mass of facts collected by us as the results of these inquiries, in the Schedules and Tables which accompany this Report, and shall therefore confine ourselves to general remarks, and to placing before you such conclusions as we think may fairly be drawn from the before-mentioned Tables.

The district to which our attention has been directed, forms, (as has been above stated), a portion of the sub-districts of three different Registrars.

It is bounded on the north by Great Marlborough Street and Noel Street; on the east by Berwick Street and Walker's Court; on the south by Little Pulteney Street and Brewer Street; and on the west by Lower John Street, Golden Square, Upper John Street, and King Street. It comprises thirty-one streets, twelve courts, and one square. The population of these sub-districts at the census of 1851 was, Berwick Street, 10,798, Golden Square, 14,139, St. Anne's, 17,335. The elevation above Trinity high-water mark is, Berwick Street sub-district, 65 feet; Golden Square, 68 feet; St. Anne's, Soho, 64 feet.

In the course of our inspection we have visited about 800 houses, calling at some, however, for purposes of inquiry only. We have annexed a Table of the streets, with the number of houses in each, and the greater number of houses visited by us. Our method has been to inspect every house in streets where Cholera has been at all general; in those streets where the cases have been few, to inspect all those houses where there have been deaths, and to take several other houses in the street, (the number regulated by the amount of epidemic disease which we found to exist,) and inspect them for the purposes of comparison, while in the case of those streets and places which have been entirely or almost exempt from the disease, *i e.*, Great Marlborough Street, Upper and Lower John Street, King Street, Brewer Street, Golden Square, and Little Pulteney Street, we have visited few houses except those where cases have occurred.

With respect to the district generally we have to remark, that the houses are let at high rents, and are decidedly not of a very low class, but are nevertheless almost universally old and inconvenient; that the streets are narrow in proportion to the height of the houses, (except in the cases of Great Marlborough Street, Great Pulteney Street, and Broad Street,) that the ends of almost all the streets, instead of being continued by other streets running more or less in a line with themselves, cut other streets or turn themselves at right angles, and that with the exceptions of Golden Square, and the space between Portland Street and Marshall Street, where the workhouse and its grounds stand, there is no open space whatever in the district; the backs of all the streets being filled up with courts, workshops, and warehouses, and here and there with cow-houses and stables. Many of the smaller streets form culs-de-sac, *e. g.*, Bentinck Street, Dufour's Place, Noel Street, Marlborough Row, Pews Place, &c.; and there is no single street or succession of streets in the whole district down which a free current of air can pass from one end of the district to the other. We need hardly add, that the ventilation of the district is very bad; in fact, although well acquainted with London, we do not know any district, composed of houses of the same class, worse adapted for proper ventilation.

During the month of August only twenty-six cases of Cholera had been registered in the sub-district of Berwick Street and Golden Square; but on the morning of Friday the 1st of September, the disease broke out with fearful, inexplicable, and fatal violence, as will be hereafter detailed, and continued with little abatement until the morning of the 5th, when it began rapidly to decline. During the latter part of Thursday the 31st of August, the wind changed from south-west to north-east, and so continued (with a slight variation on the 3d and 6th of September). During the following week the horizontal movement being trifling, the mean highest temperature in the sun during the week ending September 2, was 103·1, the mean lowest on the grass was 45·4; during the week ending September 9th, the mean highest was 98·5, the mean lowest was 37·4. The electricity was positive, with

moderate tension. During the latter days of August the sky was clear, with occasionally a few strata of clouds, but the atmosphere was hazy, more particularly on the 31st, when many intelligent inhabitants of the above-mentioned districts describe it to have been stagnant, sultry, and oppressive, to a degree they had never before experienced; several of them stated that on the evening of that day they felt it so close and overpowering within their houses, that they opened the doors and windows, and stood at the front doors without experiencing any relief.

As above stated, the prevailing winds at the time of the outbreak appear to have been from the east or north-east; one of us remarked that in the worst district, where the streets run east and west, and there is no westerly outlet, (such as Noel Street, Portland Street, and Bentinck Street, Broad Street, and Husband Street,) there is an almost invariable preponderance of cases of disease at the south-west ends. We think that the evidence bears out this remark.

While upon the general external features of the district, we may say, that the centre of pestilence was in the two blocks of houses bounded on the north by Broad Street, on the south by Silver Street and Pulteney Street, on the east by New Street, and on the west by Marshall Street. To this district we should probably have had to add the adjacent block to the east, bounded by Broad Street on the north, Berwick Street on the east, Maidenhead Court and Husband Street on the south, and New Street on the west, were it not that about two-thirds of it are occupied by the model lodging-house, the church, and Messrs Huggins' brewery, which have been entirely exempt from disease. The mortality on the immediate outskirts of this block, in New Street and Husband Street, is at least very remarkable; in fact, the model lodging-house is surrounded by deaths on every side, except where fronted by the church and brewery. We have not any materials, (such as a plan of the levels), to enable us to speak with confidence on this point, but we are inclined to think it will be found, that the centre of Broad Street, where Cambridge Street runs into it, is the lowest point of the immediate neighbourhood, and to use the expression of an inhabitant, "is the sink of the whole district, out of which the disease seemed unable to get." We reserve our remarks on the gully grates of this district until we come to the subject of gully grates and ventilating shafts.

(B.)—Nuisances, slaughter-houses, noxious trades, &c.

The chief nuisances of this district are the cesspools, which we believe exist in numbers in every street, often without the knowledge of the occupants of the houses. We need not particularize any of these, as we shall have to return to them hereafter; but would merely refer to our Tables to show how frequent they are, and the general feeling with respect to them.

There is one wholesale slaughter-house in the district, of which great complaints are made in the neighbourhood; it is

situated at the back of Marshall Street, and belongs to Mr. Holmes, a butcher, in Silver Street. Here, on an average, five oxen and seven sheep are slaughtered daily. The premises are spacious, were certainly very clean when we visited them on September 7th, and we were told that the method of carrying on the business had not been altered.

The whole of the blood, entrails, &c. are bought by contractors, who remove them daily; the premises are abundantly supplied with water, which is used very freely; there is plenty of room, and the place is as airy as the situation will admit of, surrounded as it is by other buildings; at the lower end of the slaughter-house floor there is a drain dividing into two branches, one of which runs into a large stone tank, which is left open while the slaughtering is going on, and into which the blood flows; here it remains until the evening, when it is taken away, and at the same time the offal and the rest of the refuse is removed. The other branch of this drain runs into a sewer; it is closed while the slaughtering is going on, but is then opened, and any remains of blood and filth which are left about are washed into it. We were assured by the persons employed, and the owner of the premises, that the blood washed down this drain into the sewer is so trifling that it cannot possibly coagulate, so as to create any impediment or nuisance in the sewer; on the other hand, a person employed by the Commissioners of Sewers assured us that he had often himself seen large masses of coagulated blood in the neighbouring main sewer, which could only have come from the slaughter-house in question.

Notwithstanding the apparent cleanliness of this slaughter-house, great complaints are made in the neighbourhood of the smells which come from it, and especially the smell of sour grains, on which the beasts in an adjoining cow-shed are fed, and which is represented as being worse than that created by the removal of the refuse. We have taken this slaughter-house as a favorable example of such places, but for an average specimen of the smaller slaughter-houses, we mention one at 19, Silver Street, much complained of by the neighbours; for detailed information as to which, we beg to refer you to the special report upon it made to the Board of Health by one of us, from which it will be seen that in this as in most of the other small slaughter-houses, part of the basement, commonly the kitchen, dark and ill ventilated, is the place in which they kill.

We think that this, and consequently all other slaughter-houses in the district, must exercise a serious influence on the health of their respective neighbourhoods, and ought not to be allowed to exist in so crowded a part of London. The smaller butchers, particularly those in Berwick Street, who kill only a few sheep weekly, almost invariably allow the whole of the blood and part of the offal to run into the sewer, as it is not worth contractors' while to take such small quantities. We cannot say whether this custom

is the cause of the great mortality which has taken place amongst the butchers and their families, for which we refer to the Tables. The fact is certainly strange, as their houses are in general well kept, not overcrowded, and in good condition; and they are for the most part persons in good circumstances. We may mention as a nuisance, a large tripe-boiling establishment at the back of Silver Street and Marshall Street, close to the slaughter-house before mentioned. Great complaints were made of this place by the neighbours, and we remarked that the whole of the contents of the paunches and other refuse are discharged into the sewer. The mass of this refuse entering the sewer a few yards from the spot where the before-mentioned slaughter-house discharges itself, cannot fail to cause frequent deposits. Mr. Cooper, (from the Commission of Sewers,) who was with us on the day we visited this neighbourhood, confirms us in this view, and deposits are more likely to occur, as the sewer only *commences* a few yards from here, viz., opposite the end of Broad Street, consequently there is no water or sink drainage to carry on the refuse.

Mr. York, the Inspector of Pavements, informed us, that when he passed the tripe shop in Silver Street, on November 1st, an overpoweringly offensive stench proceeded from it, and still worse at the boiling-house and slaughter-house in Marshall Street. There are in this district several dealers in bones, rags, grease, and other refuse, whose shops are much complained of by their neighbours; in the parish of St. James' alone there are seventeen such places; we think that in shops or dwellings, accumulations of imperfectly cleaned bones must have an injurious effect on the health, and should not be permitted.

No complaints were made to us of other noxious trades, except in Dufour's Place, where the inhabitants of several houses complained very much of Mr. Nicolls' water-proof and cloth-pressing manufactory.

(*C.*)—*Smells in the streets and their source, gully grates, gutters, &c.; whether the gully grates trapped, whether cases and deaths more numerous in houses near gully grates.*

Throughout all the neighbourhood, but more in some streets than others, the inhabitants complain greatly of smells in the streets; in one case the offensive smell was complained of by the neighbours as arising from the tripe-boiling establishment, and slaughter-house in Marshall Street already spoken of; also from the smell of the fermenting grains, usually kept in large quantities in the cow-yard adjoining the latter place; from the various smaller slaughter-houses in the neighbourhood, and several of the fishmongers' shops and yards, particularly one in Berwick Street; and the inmates of 22, Great Pulteney Street made great com-

plaints of offensive effluvia arising from the fishmonger's premises at 41, Silver Street. In a few other cases, people complained of a stench arising from some of the areas in consequence of foul necessaries located there; as for instance at No. 34, Berwick Street, where there was an untrapped privy and cess-pool in the front area, overflowing in consequence of the drain being stopped; it had been suffered to remain in this condition for many months, the house being unoccupied save by a person taking charge of it; with such a focus for originating disease, we are not surprised to find that the adjoining house on the right hand, the two adjoining houses on the left, and two houses immediately opposite, had one or more fatal cases of Cholera in each of them, while in the forty-four houses north of this there were only two deaths from Cholera.

With the above exceptions, the gullies were complained of as the source of the offensive smells, and in many cases we can state from our own experience, that neither were the inhabitants mistaken as to their source, nor were the complaints groundless. As to the proportion of gullies which are trapped, we are unable from our own examination to speak positively; the Commissioners of Sewers state it to be one half; but even that point appears of less importance, when we state that from some of those represented to be trapped, most offensive smells proceeded, for example, immediately opposite to 5, South Row, (the house in which the first fatal case of Cholera occurred in the Golden Square district this year,) the gully is marked in the plan of the Commissioners of Sewers as trapped, while a shoemaker, who works in the front room of the ground floor, complained of the stench proceeding from that gully being so great, as to compel him frequently to shut his window, and when he was desirous of opening it for a short time, he had recourse to the expedient of covering the gully grating with a piece of oil cloth with stones laid upon it. In Little Windmill Street and other places, as will be hereafter detailed, the inhabitants complained particularly of the offensive effluvia proceeding both from trapped and untrapped gullies.

Although it does not appear in every instance that the houses opposite to the gully gratings suffered most from Cholera, it is nevertheless an undeniable fact, that several of those houses in which the greatest mortality occurred, are situated opposite to gullies; for example, No. 23, Peter Street, a corner and double house, in which there were twelve deaths; opposite the angle of the house, and opposite to the side entrance in Green's Court, are two untrapped gullies of which the neighbours complained greatly. In this court, next door to 23, Peter Street, there were two fatal cases of Cholera; next door but two, one fatal case, and opposite, facing the side entrance of 23, Peter Street, next to the gully hole, was one fatal case, and in each of the two houses in Peter Street, adjoining No. 23, there had been fatal cases. It is right to observe, however, that the basement and two privies situated there, in the house No. 23, were in a most filthy condition, as will be stated in another part of the report.

At No. 1, Brewer Street there were six attacks of Cholera, five of which proved fatal; this is a corner house, one side being in Little Windmill Street; opposite to the entrance in Brewer Street is a trapped gully communicating with the new sewer, which the inhabitants state to be inodorous; opposite to the angle of the house is a ventilating shaft, and at the side of the house, in Little Windmill Street, is a gully communicating with the sewer constructed in 1852, and represented by the Commissioners of Sewers as being trapped, and on the opposite side of the street a similar one; but one of the survivors in the house told us that they had been greatly annoyed by the smell from the gully in Little Windmill Street, and that on the evening preceding the fearful outbreak of Cholera in this neighbourhood, the stench had been so great that they had thrown a quantity of chloride of lime down it. In Hopkins Street, Nos. 9, 10, 11, stand apart, their water-closets are all trapped, and their yards and premises are much cleaner than other houses of the same class in the locality; opposite to No. 11 is an untrapped gully, and a few feet further on another; from the former of these in particular, the landlord of the house stated that unpleasant smells issued; in this house were four fatal cases of Cholera, in No. 10 two, and in No. 9 eight.

In No. 5, Berwick Street, a grocer's, there were seven deaths from Cholera, and immediately opposite the shop is an untrapped gully grating, from which the man in the shop stated that most offensive smells issued.

In St. Ann's Court, where there were thirty-three deaths from Cholera, there are two gully holes much complained of by the inhabitants.

At No. 3, Broad Street there were nine cases of Cholera, six of which were fatal; a drain from the next house, which runs close to the back room on the ground floor, is usually very offensive, and requires constant use of chloride of lime; on the left of this house, opposite to No. 2, is an untrapped gully; at No. 4, there were four deaths, at No. 5, three, at No. 6, one, and at No. 7, one; opposite to No. 6, is a gully stated by the Commissioners of Sewers to be trapped, but on the 28th of August, the inmates at No. 8, found it so offensive, that they were compelled to close their windows in consequence.

At No. 14, Silver Street there were two deaths; the stench from a gullyhole nearly opposite was stated to have been very great on Saturday the 2d of September.

We are decidedly of opinion that the gully grates (when imperfectly trapped) and ventilating shafts, as at present onstructed, must have an injurious effect on the health of any districts; we think that such places as the tripe dressing and boiling establishments, and the slaughter houses already spoken of, not only render those parts of the parish in which they are situated unwholesome from the foul odours emitted from them, but also cause the sewers in the immediate neighbourhood, which receive the soil and drainage from them, to send forth from the street gullies, and into the un

trapped house drains, such noxious exhalations as must of necessity not only produce a predisposition to disease, but also engender it, and greatly increase the mortality in any district where epidemic disease prevails.

(D.)—Smells in houses and their source, such smells worse during the night, or in the morning before the houses or shops were opened.

In a large majority of the houses which we visited the inmates complained of bad smells of various descriptions, and we also were fully sensible of their presence, more particularly in the lower part of Marshall Street, in Little Windmill Street, Cambridge Street, Brewer Street, Silver Street, Peter Street, South Row, and St. Ann's Court; many houses in Berwick Street and Broad Street, &c. The source of these smells were generally the necessaries, although in several cases arising from collections of dust and refuse in the dust bins, but this latter cause had existed to a much greater extent before the outbreak of Cholera. In many cases also, offensive smells proceeded from the interior of the over-crowded rooms, in which slop pails and other utensils were kept, containing night soil, urine, and other offensive matter; these were emptied once in the twenty-four hours, either into the water-closet or down the sink, and, in the case of the attics, not unfrequently into a gutter on the roof, and from that by the rain-water pipe into a sink in the back yard. Several instances of this latter practice were complained of by the neighbours as occasioning a great stench. In several instances the air in the rooms and houses was rendered more close, foul, and unwholesome, by the inmates keeping dogs and other animals; for example, at No. 38, Silver Street, the man who occupied the upper part of the house kept twenty-seven dogs in one room; their excrements were discharged into the gutter on the roof, where they accumulated, and were described as emitting "a horrible stench." At No. 44, also, one death from Cholera occurred in the person of a charwoman, who kept about seventeen dogs, cats, and rabbits. In many of the houses where the drains, probably old imperfect brick ones, passed under the kitchen floors, they were a fruitful source of mal-odours; and when these did arise from that cause, or from foul closets situated within the house, more particularly in the basements, the smells were invariably, as might be supposed, worse during the night or towards morning; and it is worthy of note, that this was the period when, as far as we could draw a conclusion, the majority of choleraic seizures took place. Several of the inhabitants stated that they frequently felt sick and uncomfortable in the morning, until they had opened the doors or windows for a short time; and this was not merely the case where a number of persons occupied one room or floor, but frequently the ground floor, where no one had slept in the shop or parlour.

(*E.*)—***Whether the house had privy, or water-closet, or cesspool, and the position of these; whether complaints of smells from them; whether they were in good condition; whether the water-closets were well supplied with water; whether the house drainage stopped; whether the sinks were in good condition; their position; whether smells from them. This district has been lately drained. Ascertain how many of the houses have drains connected with the new sewers; whether the house drains pass under the house to reach the sewer; the structure of the house drains, pipe or brick drains, and their condition; whether subject to stoppage, or smells from them.***

For the information on this subject, as to each particular house, we beg to refer to our tables. Out of all the houses visited by us, we do not remember to have found one unsupplied with a necessary of some description, except the Nag's Head Mews, Portland Mews, and Brown's Court. In the first there is a gallery consisting of nine dwelling rooms (rented at 4*s.* a week each), and two ware-rooms situated over coach-houses and stables, and occupied by thirty-seven inmates (two of the rooms being inhabited by eighteen adults and children). In this gallery there had been one death by Cholera, a woman; six persons slept in the room where this woman died. There is only one trapped privy for the whole of this tenement. In a very large majority of houses, the necessaries are situated in the back yards, level with the ground floor; in almost all the remainder, the necessaries are below the level of the ground in the basement, and frequently within the building. We have already stated our belief, (which we here beg to repeat,) that there are very many cesspools in the district besides those the existence of which is known. The old cesspools have not been filled up when the house drainage was connected with the street sewers; the consequence is, that only the overflow goes away into the sewer. This remark does not apply to the Craven estate in this district, in which, (we were informed by a trustworthy authority, Mr. York, the clerk to the Commissioners of Paving,) on the last renewal of leases, the cesspools were ordered to be thoroughly removed, and new brick drains carried under the houses into the sewers. In many cases, as may be seen by our tables, we know that cesspools do exist; for instance, at No. 10, Cambridge Street, where it frequently overflows the yard; at No. 9, Bentinck Street, where it was greatly complained of by the inmates of the houses in Broad Street, which overlooked the premises. In Marlborough Row we saw a large cesspool being emptied.

In Bridle Lane a monster cesspool, formerly a dung pit, exists, which has not been emptied for many months. The complaints of smells from necessaries were general all over the neighbourhood, but the complainants oftener spoke of their neighbours' necessaries than their own; we can, however, say from our own personal experience, that scarcely any of the necessaries in the district are really free from foul smells, and that their general condition is far from satisfactory. In very few instances is the water laid on; in many instances the waste pipe from the water-butt discharges itself into

them, but this arrangement is very insufficient; in the remaining houses, (the proportions can be ascertained by reference to our tables,) there is no means of cleansing at all, except by pouring down water by hand. We remarked nothing particular as to the sinks and drains in the areas, except that many smelt badly, we conclude from defective trapping. In No. 14, Noel Street, which was the house with the greatest mortality in the street, the sink was very foul; it was situated in the kitchen. We should observe that gutter pipes communicating with the drains are a fruitful source of foul smells, more particularly in those cases where the occupants of the attics are able to empty their slops into the roof gutters. As to whether or what proportions of the drains of the houses do or do not drain into the new sewers, and their position, structure, and condition, we feel that it is useless for us to pretend to report upon the subject; our authorities would necessarily be the Commissioners of Sewers and the inhabitants, whose statements on these subjects are hopelessly irreconcilable; but we believe that, with few exceptions, the drains pass under the kitchens; among the exceptions may be instanced Marlborough Row, where the drains run back and communicate with house drains and sewers in Carnaby Street. We found several instances of stoppages; some of these may possibly be accounted for by the fact that the old sewers were made at a much higher level than the more recently constructed ones, and the house drains communicating with them were nearly horizontal, so that where a new sewer has been made in a street, and the houses drain into it by means of the old drains, frequent deposits and stoppages take place in the latter, in consequence of the little or no fall in them until near the junction with the sewer; therefore, to give full effect to the benefit derivable from a new sewer passing through a street at a lower level than the original one, it would be necessary to reconstruct the house drains communicating with it.

(*F.*)—*Examine the basements as to the depth of the floor below the level of the street; whether there had been any accumulations of house refuse in these basements, or in the adjoining cellars before the outbreak. Consider the effect of these conditions on the general ventilation of the house, especially at night; ascertain whether the dustmen and scavengers are regularly employed in removing rubbish; what their contract is; whether it is fulfilled.*

Throughout the district the basements generally were in a bad condition, being dark, dirty, damp, ill-ventilated, and frequently dilapidated; their depths on an average we should estimate at from 7½ to 9 feet from ceiling to floor, the latter being from 6 to 8 feet below the level of the street; the basement of No. 3, South Row, which we measured, may be taken as a fair specimen, it was 8½ feet from ceiling to floor, and the latter 7 feet below the level of the street; in the front kitchen on this basement there had been one death from Cholera, eight individuals occupying the room, for which a rent of 3*s.* 6*d.* per week was paid; the back kitchen, a small mise-

rable place, for which 2*s.* per week was paid, was occupied by six persons, one of whom had a dangerous attack of choleraic diarrhœa. In very few of the kitchens occupied as dwellings, were the requirements of the 53d sect. of Schedule K. of the Metropolitan Building Acts complied with, and many of these apartments were disgracefully overcrowded, especially in St. Ann's Court and neighbourhood. At No. 6, St. Ann's Court, a woman died from Cholera in the kitchen, which had been occupied by three adults and three children, the five survivors slept in it with the corpse on the night after the death; the cobler in the shop above, stated that offensive smells proceeded from the kitchen window, and hole or cellar in front area, where bones and other refuse were thrown. In No. 21, St. Ann's Court the kitchen had three beds in it, two for adults and one for children; in No. 19, St. Ann's Court the kitchen as well as the whole house was much crowded; there had been four cases of Cholera, of which two were fatal, and twenty severe cases of diarrhœa. In Nos. 2 and 3, Crown Court the kitchens were overcrowded, and like those mentioned above, as well as many others, were totally unfit for human habitations. In very few of the basements, areas, or back yards, were there large accumulations of dust or other refuse, as a few days previous to our visit the parochial authorities had sent round the dustman to remove the contents of dust-bins, &c., but before the outbreak of Cholera most offensive accumulations were allowed to remain for five or six weeks, and longer; many of the inhabitants complained that they could not get the dustmen to empty the ashpits, &c. without feeing them. On inquiry as to the nature of their contract and its obligations, the Surveyor of Pavements, Mr. York, informed us that there were two contractors for the whole parish, they were bound to send round their carts daily, and remove any collection of dust, &c. when required to do so by an inhabitant; if they refused or neglected to do so, application to the Paving Board by the aggrieved inhabitant, was invariably successful in procuring a removal of the dust, &c. within twenty-four hours, but many of the inhabitants were unaware of this mode of obtaining redress, and probably many who were aware of it were unwilling to act upon it, as Mr. York, jun., stated that the applications to compel the dustmen to do their duty were very few. We would suggest the propriety of making the dustmen empty each ashpit at stated periods, and oftener if required, and of making their non-compliance, after a request to do so by an inhabitant, punishable by a small fine; full information on this point should be printed on the receipts given by the Paving Commissioners. The action of accumulations of dust, of vegetable and other refuse, for a lengthened period, even when the receptacles are in the yard or area, must be very injurious to the health of persons in the vicinity, but where the receptacles are in the basement within the building, as is frequently the case in this neighbourhood, the pernicious action on the health of the inmates must be greatly increased, and cannot fail to become in many instances an active source of disease.

(*G.*)—*Examine the houses as to their general cleanliness and means of ventilation. Examine also the back yards, and inquire what was their condition before the epidemic. Note if they be flagged or filthy, &c.*

In the inferior streets, as Peter Street, Hopkins Street, South Row, &c., the general character of the houses, as regards cleanliness, is much as is usually met with in London in houses of the same class; with few exceptions, separate families occupy every floor, and in many cases every room in the house, and as a general consequence in such cases, the passages, stairs, and walls are extremely dirty, as well as the interior of the rooms; on entering which, we found the air close, oppressive, and tainted with a combination of unwholesome odours, arising from a number of persons cooking their food, eating, sleeping, washing and drying their clothes in the same apartments, their personal ablutions being little attended to; living in such a condition, and inhaling such a polluted atmosphere day after day, must of necessity produce a predisposition to disease, if it does not actually engender it. In some of the better description of streets, as Berwick Street, Silver Street, &c., in houses with shops, and occupied by a thriving and respectable class of tradesmen, we found the basements in a much filthier condition than we should have expected; this arose in many instances from the entire absence of back premises, and therefore the water-closet and dust-bin had to be placed in the front area, or within the building, the basement being generally dark, damp, and ill-ventilated. We beg to refer to our tables for an account of the ventilation of the houses in each street, but we wish particularly to remark that in many of those houses where the ventilation is unobjectionable, the advantages derivable therefrom are in a great measure neutralized by the space at the back being filled up by workshops and other buildings. Generally speaking we found the back yards tolerably clean, as much so as the nature of the premises would admit, some improvement being, no doubt, in consequence of the parochial visitation which had been set on foot, although the inhabitants, with a few exceptions, stated that they were much in their usual condition. Many of the smaller yards were flagged all over, those which were not, and the larger ones, had usually a strip of pavement laid along the centre.

(*H.*)—*Examine whether the disease occurred in the upper or lower flats. Get, if possible, the proportion of cases in the flats.*

For detailed information as to the streets, houses, and flats, in which the greatest mortality occurred we refer to the tables which accompany this report; the accuracy of which, as regards the number of deaths, may be relied upon, our inquiries at the houses having been verified by one of us at the various hospitals and workhouses, where many of the deaths had occurred; but we found it exceedingly difficult to obtain satisfactory information as

to the proportion of attacks, in many instances so much time having elapsed before making our inquiries, and the inmates of a large number of houses having in the mean time left the neighbourhood, while those who remained were unable to draw the distinction between Cholera and diarrhœa.

(*I.*)—*Estimate as closely as you can the condition of the inhabitants as to overcrowding, personal cleanliness, habits, diet, &c.*

Throughout the whole neighbourhood, with few exceptions, the houses were very much overcrowded, as stated in paragraph G., many families reside in rooms or tenements belonging to a non-resident landlord, and wash, dry, cook, and sleep in the same apartment; for more detailed information as to the number of inmates in each house or floor, we refer to our schedules. Although in some streets, as Peter Street, Husband Street, &c. the inhabitants might be described as dirty, yet in the other and major part of the district the inhabitants, as regards personal cleanliness, were on a par with persons of the same class in similar metropolitan localities; this observation may be made in respect to their habits and diet, as we found about an average amount of intemperance and improvidence, and consequently of poverty, and although we scarcely met with a case in which an intemperate man recovered from Cholera, we nevertheless met with many fatal cases occurring to those who had lived regularly and well, and who up to the period of seizure had been considered healthy and robust.

(*K.*)—*Get the number of cases in each house, and the number of deaths of persons who lived in each house.*

Vide paragraph (H.)

2*d. Examine the water supply as to,—*

(*A.*) *Its source.*
(*B.*) *Quality.*
(*C.*) *Amount.*
(*D.*) *Whether drawn from pipes or water-butts, and the condition of the butts.*

The sub-districts of Berwick Street and Golden Square are supplied by the Grand Junction and New River Companies, St. Ann's, Soho, by the New River only; the quality of the water, especially that of the New River, although not what could be desired, is much superior to some, and we believe equal to that supplied by any of the metropolitan water companies. We heard little or no complaints throughout the district, either as to the quality or the amount of supply. We again refer to our schedules for particular information as to whether the water was kept in butts or cisterns, and the position of these, which, as well as their condition, we found with few exceptions most unsatisfactory; they were in many cases wholly or partially uncovered,

not having been cleaned for months, in some cases for years, and having an accumulation of dirt at the bottom and adherent to their sides. In many cases the butts, and more particularly the cisterns, were situated in the basement within the building, in close, unwholesome, and disgusting propinquity to the water-closets and dust-bins, in positions where the water could not fail to become impregnated with exhalations from the former, and solid particles from the latter.

3*d*. *Note the general condition in the streets and courts, and inquire what was the state of the cleansing before the outbreak.*

With probably a few exceptions, as Bridle Lane, Peter Street, &c., we saw little to complain of in the general cleanliness of the streets, and we were informed that the condition was but little different previous to the outbreak.

4*th*. *Examine whether the disturbance of the ground in making a sewer through the old burial ground in Little Marlborough Street, or the filtrations from it into the sewer, or the drainage of any nuisance into the general sewerage of the district had had any effect, or whether the sewers had accumulations in them that might have been injurious.*

We found two opinions, amongst others, prevalent throughout the neighbourhood; one, that the disturbance of the old burying ground was the chief cause of the outbreak of Cholera, the ravages of which, many of the inhabitants maintained, followed the line of the new sewer, the other, that a pump in Broad Street was at the bottom of the mischief. Neither of these causes, we believe, affords a satisfactory reason for the outbreak; both, we suspect, have been prominently put forth by interested persons, who were desirous of diverting the current of popular indignation from their own particular nuisances. For example, we found the owner of the monster slaughter-house in Marshall Street, and who had also an interest in the tripe boiling establishment adjoining, to be one of the loudest and most eager in declaiming against the sewers, and maintaining that the disease followed the line of the new sewer. In reference to these opinions, we may observe, that no case of Cholera occurred in Little Marlborough Street, through which a new sewer was constructed last year, and which street is represented by the Commissioners of Sewers to be the centre of the plague pit; but we believe it is not, as Mr. York, Clerk to the Paving Commissioners, and who is evidently well acquainted with the antiquities of the neighbourhood, assured us that he had seen old plans of the ground, of an authentic character and of a date anterior to the present houses, which represented the pest field as extending considerably to the south and east of that stated by the Commissioners of Sewers; it embraced King Street, Carnaby Street, west side of Marshall Street, and the ground between. But even were this

position of the pest field the correct one, it does not enable us to attribute to the circumstance of the new sewer being constructed through it, the outbreak of Cholera in this neighbourhood; for even admitting, for the sake of argument, the various theories as to the summer heat drying the clayey earth, causing it to crack, and so permitting the pestiferous emanations to escape, or filtrations from the old burial ground permeating into the sewer, &c., &c., we have to remark that the virulence of the Cholera manifested itself in Cambridge Street, Broad Street, Berwick Street, and other places, as St. Ann's Court, &c., still more remote from any spot pointed out as a portion of the pest field. Another portion, however, of the line of the new sewer, from Great Pulteney Street eastward in Silver Street, which appears to have been the site of an old burying ground, seems to have been visited by Cholera with great severity. We may say generally, that although several of the streets in which the new sewer has been constructed have suffered severely from Cholera, we also find that in the same neighbourhood many other streets through which the new sewer runs, have been almost or entirely exempt from disease. Among the former we may mention South Row, Marlborough Row, Great Pulteney Street, east end of Silver Street, &c.; among the latter, Little Marlborough Street, north end of Marshall Street, Brewer Street, &c. A reference to our tables will show that one of the places where Cholera was most fatal was the south-west end of Broad Street, between Marshall Street and Cambridge Street, where a new sewer was built during the year 1851, with a fall southward towards Cambridge Street and Little Windmill Street. In the other portion of Broad Street, east of Cambridge Street, Cholera was scarcely less fatal; here and in Poland Street the sewer was built in 1823; it discharges itself into Berwick Street, and is entirely unconnected with, and perfectly independent of, the sewer above alluded to, built in 1851. The mortality from Cholera was very great in New Street, Peter Street, St. Ann's Court, &c., places supplied by the old sewers.

The drainage of certain nuisances into the sewer, as for example, the slaughter-house and tripe boiling establishment in Marshall Street, and the deposit occasioned by the coagulated blood from the former, and the refuse from the latter, must have a deteriorating effect upon the health of the immediate neighbourhood, and favour the progress of epidemic disease; nevertheless, from the facts above stated, we consider that the outbreak of Cholera cannot be specially attributed to the disturbance of the old burial ground, the construction of any one sewer, or drainage of a nuisance into any particular portion of the sewerage of the district, seeing that the Cholera was equally fatal in different streets supplied by sewers which have no communication with each other, and have separate outlets into the Northumberland Street sewer, three quarters of a mile distant.

The following is a list of the streets in which the new sewers were completed in February 1854, respecting which a reference

to our tables will show to what extent they suffered in comparison with the others—

Queen Street, Oxford Street.
Marlborough Mews.
Blenheim Mews.
Blenheim Street.
Argyle Place, from Argyle Street to King Street.
King Street, from Argyle Place to Foubert's Place.
Little Marlborough Street.
Foubert's Place.
Tyler's Street.
Tyler's Court and Marshall Street, from South Row.
South Row.
Cross Court.
Cross Street.
Lowndes Court.
Marlborough Row.
Silver Street, from Bridle Lane to Windmill Street.
Great Pulteney Street.
Glasshouse Street, Brewer Street.
Little Pulteney Street, from Regent Street to Windmill Street.
Great Crown Court.
Little Crown Court.
Archer Street.
Part of Regent Street.
Smith's Court and Yard.

We now come to the second prevalent opinion, viz., that the impure condition of the water in the Broad Street pump was the main cause of disease. As to this, we are bound to say that there are some cases of disease and death which we find ourselves unable to explain upon any other hypothesis than that of the deleterious influence of this water.

Two such cases which came under our observation are exceedingly interesting, and as they are probably the most important which have been brought forward in connexion with this question, we think it right to state them at length. Mr. Eley, a percussion cap manufacturer, has his premises at 38, Broad Street, but lives with his mother at West End, Hampstead; this lady, being partial to the water from Broad Street pump, used to have a supply sent to her, and on Thursday, the 31st of August, had some sent up to her as usual; of this she partook freely, as did also a niece who was on a visit to her; a servant in the house partook more sparingly. On Friday, September 1st, Mrs. Eley was seized with Cholera, and died on Saturday. On Sunday the niece returned to her own residence at Islington, was attacked by Cholera on the same or following day, and died; the servant had a slight attack of diarrhœa. There had been no case of Cholera in West End previously, nor up to the period of our inquiry some weeks after, neither had there been any case of Cholera in the part of Islington where the niece resided. Mrs. Eley had not been in the neighbourhood of

Broad Street during the past year, nor, so far as information could be obtained, in a locality where Cholera prevailed, certainly not for a week previously, as during that period she had not extended her walks beyond her own neighbourhood, the Finchley Road, &c.; the only indirect communication which could be traced between her and any Cholera patient was through the medium of her son, who went daily to his manufactory in Broad Street, and had frequent communications with one of his men, who resided on the premises and was suffering from an attack of Cholera, from which he recovered; Mr. Eley, however, being in no way affected by the disease. Mr. Eley rarely drank the water from the pump, but, the water bottle in his bed-room being occasionally filled with it, Mr. Eley had frequently remarked, that after being drawn forty-eight hours, it had a most unpleasant taste and flavour, as if dead mice were in it. Again, Mr. Wickwar of Brighton, had been summoned to see his brother, attacked by Cholera, at 6, Poland Street; on arriving there, and finding his brother dead, he declined to see the body, but remained for about twenty minutes in the house, and partook of a slight luncheon of rump steak, together with a little cold brandy and water, which water was from Broad Street pump; he then went to Holford Square, Pentonville, was seized with Cholera the same night, and died. This latter case is not by any means so striking as the first mentioned, as it may be said by some that Mr. W. had imbibed the poison while breathing a choleraic atmosphere for twenty minutes. Several other persons in the neighbourhood stated, that they had repeatedly found the water from Broad Street so unpleasant that they desisted from drinking it for a time. At 10, Cross Street, where eight deaths from Cholera had taken place, one of the survivors stated they had been in the habit of drinking water from Marlborough Street pump till within a day or two of the outbreak, when finding it exceedingly unpleasant, they sent for some from Broad Street.

In many of the cases investigated by us, it was proved that the individuals had been in the habit of using that water; many mechanics working in the district, and who usually drank of the water, were attacked by Cholera at their own houses, situated at a distance; for instance, at Mr. Ash's artificial tooth, &c., manufactory, 8 and 9, Broad Street, seven such cases occurred, one of the men having been visited by one of us, at his house in Seymour Street, St. Pancras, where Cholera was not prevalent. On the other hand, our Tables will equally show many instances in which persons drinking this water either were never attacked, or recovered when attacked; and many in which deaths in the infected district occurred, of persons who were not in the habit of using this water; whilst the range of the disease extended beyond the limits within which the water from this pump was drank.

Two remarkable instances, where a large number of people living or working in the centre of the district escaped from Cholera, deserve particular notice. The workhouse in Poland Street lost only five of its inmates out of 535, exclusive, of course, of those persons who were brought in labouring under the disease; the

inmates of the workhouse had not used the Broad Street pump water, having a pump well on the premises, in addition to being supplied by the Grand Junction Company. In reference to the workhouse, we were happy to observe that the condition of the interior as well as the dietetic and general treatment of the inmates, were as satisfactory as circumstances would admit of. The other case we have alluded to, is the brewery in Broad Street, none of the men working there having died of Cholera, and none of them, as far as could be ascertained, having drank water from any of the street pumps, as there is a deep well in the brewery, in addition to the supply from the New River.

The alleged reason for the deleterious effects of the pump water is the presumed percolation of the sewage into the pump well. But a careful examination of the latter has failed to reveal any defect in the brickwork through which such contamination could take place; nevertheless, a permeation might take place to a slight extent, without discovering the precise spot where it took place, and certainly such an occurrence appears by no means improbable, when we consider the close proximity of the sewers to the well, independent of the percolation which may take place from the imperfect house drainage of the neighbourhood, several necessaries with cesspools being situated in the areas within a few feet of the well, and on a higher level. Mr. York informed us, that the line of sewer is ten feet distant from the pump, the sewer being twenty-three feet below the surface of the ground, the well twenty-eight feet deep, and the surface of the water twenty feet below the level of the street. From the date at which we made our inquiries we were unable to make any analytical or microscopical examination of the water, and can therefore give no personal opinion as to its condition, nor is there any necessity for our doing so, as this part of the investigation has been made by abler hands under the direction of the General Board of Health.

Having now replied in detail to the Heads of Inquiry furnished to us by the General Board of Health, we beg to offer a few general remarks on some points connected with the sudden outbreak of Cholera in St. James' and St. Ann's, an outbreak, which we believe to be unprecedented, at least in this country, as regards its mortality, extending so fearfully as it did over a large district,—more than decimating the inhabitants of several of the streets and courts, as Broad Street, Hopkins Street, Pulteney Court, &c. The number of houses in which attacks took place was more remarkable even than the number of victims in a street; thus, in Broad Street, which contains forty-nine houses, excluding the brewery, we found that only one house, or at the most two, on the south side of the street escaped,* on the north side eleven houses escaped, including the six corner houses. The population of Broad Street at the last census, allowing for the houses since pulled down, was about 860,

* There was some doubt as to the second house, in consequence of the former occupants having left, and the statements of the neighbours being contradictory.

the recent mortality from Cholera was ninety, in addition to twenty-five fatal cases occurring to persons working in Broad Street, but dying in other parts of London, some of them having first complained of indisposition while at their work in Broad Street; as for example, in Mr. Eley's percussion cap manufactory, No. 38, Broad Street, where sixteen of the work-people (two men and fourteen girls) died of the disease at the commencement of the outbreak in St. James'; the houses of those whom we could trace being situated, however, in districts of London where Cholera was prevalent, as Lambeth, &c.

Throughout the surrounding neighbourhood, the mortality was more or less on a par with Broad Street. For example—

In Hopkins Street, where all the houses except three had been pulled down, these three containing about sixty-seven inhabitants, the deaths were fifteen; in Cambridge Street, fourteen houses, population 179, deaths sixteen, ten on the west side, six on the east; Kemp's Court, six houses, population seventy-eight, deaths nine, in three houses.

In Pulteney Court, nine houses, population under 200, deaths twenty-four, only one house escaped.

New Street, nine houses, ten deaths, one house only escaped.

In St. Ann's Court and Place, containing thirty-three houses, forty-six of its inhabitants died. In Cross Street, Marlborough Row, Berwick Street, &c. the mortality was also very great; but as the number of deaths in each house and street is given in the tables which accompany this report, it will be unnecessary to allude further to them at present.

One of the most important and singular features in the fearful outburst of Cholera in St. James' and St. Ann's, was its suddenness, and the large number of individuals attacked simultaneously in different parts of the district; the epidemic having attained its acme on the second, if not on the first day of the outbreak. Its intensity remained stationary for two days after, and then on Tuesday, the 5th of September, and also the fifth day of the outbreak, the deaths declined by about 50 per cent. The virulence of the disease also abated as the attacks became less numerous; for during the first days of the outbreak almost every attack proved fatal, but after a few days the medical attendants were gratified by finding an occasional recovery take place. On inquiring among the practitioners residing in the neighbourhood, they informed us that although there had been a few cases of Cholera during the month of August, there had been nothing connected with the general health of the district to lead them to apprehend any outbreak of endemic or epidemic disease, the condition of the neighbourhood, as regards existing nuisances, overcrowding, &c. being much the same as in 1849, when St. James' was, next to Hampstead and Paddington, the most lightly visited of all the metropolitan parishes; and since that period, considerable improvement had been made in the drainage of the district, by the

construction of new sewers in many of the streets. Dr. Parkes, the registrar of the Golden Square sub-district, informed us that the first death from Cholera registered by him occurred on the 6th of August, at No. 5, South Row, the victim being a breeches maker, aged 47.

The second death was that of a female child, aged one year, and occurred on August 11th, at 6, King Street.

The third death, on August 13th, was a dressmaker, aged 40, in Broad Street.

The fourth was a policeman, aged 36, at 11, Edmund Court; only six more deaths from Cholera were registered by Dr. Parkes up to August 31st inclusive, but on September 1st, five deaths were registered by him (the disease having taken place during the preceding twenty-four hours).

On September 2d he registered 43 deaths.
„ 3d (Sunday) none.
„ 4th he registered 48 deaths.
„ 5th „ 31 do.
„ 6th „ 20 do.
„ 7th „ 16 do.
„ 8th „ 8 do.
„ 9th „ 11 do., including 5 from the workhouse, up to 2 o'clock, the date of our inquiry.

On inquiring of Mr. James, the registrar of Berwick Street sub-district, we ascertained that he had only registered six deaths as occurring in August, namely:

On August 7th, a woman at 21, Great Windmill Street.
„ 16th, a man at Berwick Street.
„ 16th, a woman at 76, Berwick Street.
„ 19th, a man at 76, Berwick Street.
„ 27th, a woman at 6, Queen's Head Court.
„ 30th, a man at 32, Little Pulteney Street.

Mr. Jones, the registrar of St. Anne, Soho, registered only five deaths from Cholera during the month of August, namely:

On August 21st, at 19, Crown Street.
„ 24th, „ 22, Porter Street.
„ 27th, „ 9, Gerard Street.
„ 29th, „ 7, Grafton Street.
„ 31st, „ 16, King Street.

The total number of death in the three sub-districts on the 1st and 2d of September, including those of persons who had been removed to the hospitals and workhouses, was 201; from September 1st to 13th both inclusive, the deaths amounted to 569; from that to the 20th (which was the first day in the month on which no death took place) the number was 31, and up to the 30th only 10 more occurred, making the total number of deaths from Cholera during the month of September in these limited districts 609.

On looking through the Registrar General's reports for 1849, we are not surprised to find that the streets, and in some cases the houses in which deaths then occurred, have again suffered during the recent visitation; for example, at 10, Cross Street, where a death from Cholera occurred on July 5th, 1849, eight deaths took place during the first week of last September. Marshall Street, South Row, Little Windmill Street, St. Anne's Place and Court were noted among the most infected localities of the district in 1849, and appear in much the same unfortunate pre-eminence now. As to the floors in which the greatest mortality has occurred, we beg to refer to the tables which accompany this report; but in reference to this subject we should wish to quote some observations contained in a pamphlet written by the Rev. Mr. Whitehead, the exemplary and indefatigable curate of St. Luke's, Berwick Street; he writes,—" Of the 373 deaths to which the writer confines his attention, no less than seventy-one were those of householders, or of members of their families. This mortality in the families of householders is especially noticeable on the east side of Berwick Street, being at the rate of 37 per cent. of the deaths. In Broad Street it was 14½ per cent.

" This fact of itself disposes of a statement which has gone the round of the papers, to the effect that the vast majority of the deaths occurred in the upper rooms, as it is notorious that in these streets householders and their families do not occupy the top, but rather the bottom of their houses. Even if that statement were true, the inference sought to be drawn from it, viz., that the habits of the people who occupy the top floors had more to do with the cause of the pestilence than any foul exhalations from beneath, would not be a fair one, both because every one knows that in a neighbourhood like this there are far more persons living on the second and third floors than in the kitchens, parlours, and first floors, and because it is plain that whilst very many who live at the top must have occasion to come down stairs in the course of the day, hardly any who live below are likely to go up; and so it might happen that the occupant of the garret should take the disease at such times when he was below. But the real truth is sufficiently at variance with the statement in question to lead to an inference, if such inferences be allowable, of a precisely opposite nature. The deaths of persons living and sleeping on the ground floor were more numerous, in proportion to the number of its occupants, than those on any other floor, and that without counting the non-resident workmen, shopmen, &c., who must have taken the disease on the ground level, and who went or were removed to their own houses to die. But the writer does not choose to rest this statement on mere loose assertion; his previous acquaintance with the people and their houses, added to personal observation, and the observation of his colleagues, of the progress of the pestilence, has enabled him to ascertain what, probably, for obvious reasons, no one else could or can ascertain, the name of each deceased person, and the room in which he or she died; or, in case of removal or departure, the room hitherto occupied by the deceased.

"Deaths in or from	kitchens	- - -	13
" "	houses and cottages with no floor above the first	-	9
" "	ground floor	- - -	60
" "	first floor	- - -	100
" "	second floor	- - -	114
" "	third floor	- - -	73
" "	workhouse	- - -	4
	Total	- - -	373

"It must be admitted that ten houses in which the deaths were numerous, and which have no third floor, are here reckoned; but when it is added that the deaths in them which took place on the ground floor exceeded those on the second, the admission need not go for much. In Broad Street, if the kitchens and parlours be reckoned together, the deaths were as nearly as possible equally distributed, about twenty to each floor, the extra four to the ground and second. It is noticeable that the streets and parts of streets to the north of Broad Street, and those furthest removed from it on the south, as Peter Street, Green's Court, Little Pulteney Street, Little Windmill Street, and Wardour Street on the east, are those in which the deaths on the upper floors preponderate. In Little Pulteney Street three out of the seven deaths, and in Wardour Street four out of the nine, were on the third floor."

The latter paragraph of the above, and the streets mentioned, bear out the experience of ourselves and others, as to those houses which are filthy below, and overcrowded throughout, having the greatest mortality in the upper floors, a fair example of which we have more particularly detailed in our schedules in the case of South Row. Having alluded to Mr. Whitehead's pamphlet, we beg to quote further from it:—

"In 1 house there were	11	deaths*	=	11
In each of 3 others	8	do.	=	24
" 2 "	6	do.	=	12
" 8 "	5	do.	=	40
" 7 "	4	do.	=	28
" 22 "	3	do.	=	66
" 46 "	2	do.	=	92
" 96 "	1	do.	=	96
In the Workhouse	4	do.	=	4
Total		- -	-	373

"There were no less than twenty-one instances of husband and wife dying within a few days of each other. In one case, besides both parents, four children also died; at 10, Cross Street, a woman lost her husband and five grown-up children; two other deaths

* We presume Mr. W. alludes to 23, Peter Street, among the inmates of which we ascertained that twelve deaths had taken place.

occurred in the same house. In another, both parents and three of their four children. In another, a widow and three of her children.

"At an average distance of fifteen yards from St. Luke's Church stand four houses, which collectively lost thirty-two persons."

Mr. Whitehead states, that after a careful examination of the Registrar's returns, he ascertained the proportion of deaths at different ages, in St. Luke's district, to be as follows:—

Aged 10 years and under	- - - -	66 deaths.
Aged from 10 years to 20	- - -	24 do.
" 20 " 30	- - -	44 do.
" 30 " 40	- - -	50 do.
" 40 " 50	- - -	56 do.

and so on, to 80 and upwards, at the rate which might be expected.

The twenty-four deaths in the second decade are thus distributed:—

Aged 11 years	- - -	5 deaths.
" 12 "	- - -	5 do.
" 13 "	- - -	4 do.
" 14 "	- - -	2 do.
" 15 "	- - -	0 do.
" 16 "	- - -	1 do.
" 17 "	- - -	0 do.
" 18 "	- - -	2 do.
" 19 "	- - -	3 do.
" 20 "	- - -	2 do.

As to any other special liability or exemption of any particular class, there is very little to be said. One thing at least is certain, that the very old and the very poor have not supplied nearly so many victims as might have been anticipated, whereas the householders have supplied rather more than their due proportion.

The introductory paragraphs in Mr. Whitehead's pamphlet are interesting, as showing the fearful mortality in a limited area:—

"If a person were to start from the western end of Broad Street, and, after traversing its whole length on the south side from west to east, to return as far as the brewery, and then, going down Hopkins Street, along Husband Street, and up New Street, to end by walking through Pulteney Court, he would pass successively forty-five houses, of which only six* escaped without a death during the recent outburst of Cholera in that neighbourhood."

According to a calculation based upon the last census, those forty-five houses contained a population of about 1,000, out of that number 103† perished by pestilence.

* And from three of these six, no less than eighteen non-residents caught their deaths, sixteen from one factory.

† Here, and throughout this narrative, the deaths recorded are only those of persons resident in the district at the time of the outburst of the pestilence, who died many of them at their own houses, some in the workhouse, others at the hospitals, and a few in the country, having fled thither for security.

Returning to Broad Street from Pulteney Court by way of Cambridge Street, he would, indeed, find a few houses in that short street which were spared, but he would still hear of its population being almost decimated, as it lost sixteen of its 179 inhabitants.

Taking a more comprehensive view, he would find the western half of Broad Street to have been about the centre of the infected district. Starting from thence, any one walking at a moderate rate in any direction might have gone beyond its limits in less than three minutes.

On hearing of the late fearful outburst of Cholera, the question which we heard asked on all sides, and which naturally suggests itself to every inquiring mind, is, What was the cause? The very importance of the question makes us diffident in replying to it, nor could we receive any satisfactory answer to it from the medical practitioners, or from the more intelligent of the inhabitants in the district; the sewers, the air, the water, &c., were each assigned as the cause, more particularly the sewers. For ourselves, we have no new theory to offer. We are inclined to believe that there existed a peculiar condition of the atmosphere, which has been called choleraic, wherein the exhalations from sewers, impure water, bad house drainage, overcrowding, intemperance, fear, may operate on individuals, so as to produce the disease; nor can we call to mind an instance in which the sufferer had not been exposed to the action of some of those circumstances which, during the prevalence of epidemics, act as fuel on a fire.

Allowing, indeed, more than their utmost effect to the miasmata diffused by the construction of the new sewer,—to the unhealthy condition of the water from the Broad Street pump, we cannot help thinking that the outbreak mainly arose from the multitude of untrapped and imperfectly trapped gullies and ventilating shafts constantly emitting an immense amount of noxious, health-destroying, life-destroying exhalations, the intensity of which must have been greatly increased by the structural peculiarity of the streets, and by the stagnant condition of the atmosphere at the time of, and preceding the attack. Thus, as the poisonous emanations rose from the sewers, they remained suspended in the immediately surrounding atmosphere, which was remarked at the time to have little or no horizontal movement. The benefit of what little movement did exist, would be mostly experienced at the corner of the streets; and it is a remarkable fact that houses thus situated experienced a decided immunity, except in the case of those corner houses where abundant "materiæ morbi" existed in, or adjoining the premises, as, for instance, at the corner of Little Windmill Street and Brewer Street, where several most offensive gullies at the side, and a choked-up necessary behind, belonging to the next house, sent up their pestiferous vapours. As a proof of the immunity of several corner houses, we may mention the six corner houses on the north side of Broad Street, although the street itself was the most heavily visited in the district.

With regard to the sanitary improvements desirable to be carried out, in order to guard as much as possible against any

future visitation of a similar character, we beg to offer a few suggestions.

The first and most important which we would recommend is a compulsory and more perfect system of house drainage, and the filling up and abolition of every cesspool in the neighbourhood, for we are convinced that a much larger number exist than we have ascertained, or than is generally supposed, as only a limited number can be proved to have been filled up, and it is well known that there was one belonging to every house at a period not more remote than about twenty-five years, for it is only within that time that water-closets have been generally permitted to drain into the main sewer.

A striking instance of the beneficial sanitary effects resulting from good house drainage was brought under our notice by Mr. York, who stated that eight houses namely, Nos. 12, 14, 15, 16, 38, and 40, Marshall Street, and 25 and 28, Broad Street, which had been efficiently drained into the new sewer, and had flap traps placed at their further extremity, at the trifling cost of 14*s*. each, had all escaped Cholera, while as our tables will show, the surrounding houses had been severely visited. We would suggest the adoption of some measure to prevent the occupants of attics converting the gutter on the roof, or the rain water pipes, into common sinks; we also think it should be imperative to have every house provided with a separate and properly trapped water-closet, having the water laid on; also that the dust-bins should not be situated within the building, and that they should be emptied at regular stated intervals.

As to the main sewers, much advantage would be gained in the way of preventing accumulations, &c., if a greater fall could be obtained, as that which now exists in this district, namely 1 in 250, appears very inadequate. We also recommend that all untrapped gullies and ventilating shafts in the streets should be prohibited; we are aware that the question of a judicious ventilation of the sewers is a difficult one, and we do not feel ourselves competent to offer any opinion on the subject, but we consider it our duty to state most positively, as the result of careful observations, and mature unprejudiced reflection, that the present system of ventilating the sewers is highly detrimental to the public health. As to the removal of slaughter-houses, noxious trades, and nuisances from the proximity of dwelling houses, the desirableness of doing so appears so self-evident, that we will adduce no arguments in support of it, but merely bring the subject under your notice.

As has been remarked at the commencement of this report, the structural arrangements of the streets are extremely ill adapted for proper ventilation, and consequently for the removal of any noxious exhalations engendered in the locality, we therefore deem it very desirable that freer continuous openings should be made through the district; for instance, as was suggested a few years ago by a committee of the inhabitants, that a direct thoroughfare should be made from Berwick Street into Rupert Street, and that all culs-de-sacs should be done away with. We likewise advise

that the parochial authorities should be required to see the provisions of the 53d sect. of the Metropolitan Buildings Act fully carried out, in order to prevent such cellars and kitchens as we met with in St. Anne's Court, &c., from being occupied as human dwellings, and we hope that the erection of model lodging-houses and other suitable dwellings for the working classes will be continued.

Another important subject to be noticed, is the water supply; although we did not hear many complaints of deficiency of water, we know there was no superabundance, and the place and mode of keeping it is highly objectionable, as the situation of the cistern or butts prevented their being regularly or properly cleansed, and rendered their contents liable to foul impregnations, and we hope that among the important sanitary measures to be brought before Parliament, the question of an unintermitting supply of pure water to every house in the metropolis will not be lost sight of.

We cannot conclude our Report, without alluding to a fact which struck us all repeatedly during our inspection. It was, that in every street of this district there were palpable nuisances, existing notoriously and known to every one, and yet that the power or the will to remedy them was not forthcoming.

Now, in justice to the parish authorities we must say, that they appeared ready to do all in their power towards abating nuisances which were brought under their attention, and were within their jurisdiction; nor had we any reason to complain of the Commissioners of Sewers or of Pavings, or of water companies or gas companies, or of any other public or private body. But the very readiness of all persons and bodies connected directly or indirectly with the public health to do all in their power on this occasion, only throws out the aforesaid fact into stronger relief. There were the nuisances; day after day we passed them, and people on all sides talked to us about them, and yet nobody could or would remove them.

We may perhaps be allowed to say a few words on this subject. One great cause, perhaps the great cause of the evil, is the punctilious regard for private property and vested interests which Englishmen cannot get over, even when the Cholera is at their doors. The consequence is, that monster nuisances remain infecting the air, while the parish authorities, or whoever else has taken up the matter, are corresponding with landlords or occupiers, or running after some other person who, or public body which, has more right than they, in the first instance, to set things straight. Now sanitary inquiries have clearly shown that landlords and occupiers, who allow certain conditions of things to exist in their houses or on their premises, are injuring the public. Where those conditions are found, therefore, the power of acting, at once, effectually, and at the sole expense of the parties, without any previous notice from householders or other machinery whatever, ought to be vested in the one authority in each parish or district, whatever that may be, which is responsible for the public health.

And here we have touched upon another question, to which a definite answer must be given, before we can hope for any very sensible improvement in the sanitary condition of the metropolis. What is to be the authority responsible for the public health? or is there to be any such authority? or are there to be six or seven such in each district? At present the guardians, under the direction of the Board of Health, are popularly supposed to be responsible for the healthy state of their respective parishes, and to have the necessary powers in this behalf. But while the enforcing of the Smoke Act and other sanitary laws affecting the air and the surface of the ground are left to the police and the magistrates, and the supplies of water, gas, and sufficient sewer accommodation to three influential and independent bodies, each of which has power to limit its supplies, and for its own purposes, and at its own time, to break up the surface of any thoroughfare or court, and to heap them for days and weeks with all manner of filthy substances, it is impossible to say that the unlucky parish authorities have the means of performing their trust.

We sincerely trust that the new Acts about to be passed may provide for more complete co-ordination between these bodies. The appointment of permanent inspectors of nuisances might help to solve the difficulty. If they are clothed with ample powers of entry into all houses and places whatsoever, and the parish is empowered upon a simple complaint from them, without further notice, to abate all private nuisances at the expense of the parties causing the same; and if the magistrates may enforce the Smoke Act upon similar complaints from them; and if no paving commissioners, sewers commissioners, improvement commissioners, water companies, or gas companies, are to be allowed to break up the streets or commence new works, without communicating through these permanent inspectors to the parish authorities and the Board of Health, we think that great progress will have been made in sanitary reform. Every one having the least acquaintance with such matters, must at any rate feel, that until some such co-ordination has been established by this or some other means, no great improvement can be hoped for.

Above all, let all avoidable formalities be dispensed with, which may in anywise hamper the transmission to the proper authorities of the earliest possible knowledge or even suspicion of any nuisance, or which may tend to fix patently on individuals the responsibility for any complaint in sanitary matters. To exact a formal notice from the occupier of any alleged nuisance on the premises he occupies, is absolutely to defeat the ends of sanitary reform. Owing to the deficiency of house accommodation, and the consequent high rents exacted, the occupier is almost invariably at the mercy of his landlord; and for him to complain openly of a nuisance, is often as much as to invite a distraint, or at least a notice to quit. We could quote numerous instances in which information of nuisances of the worst description was extracted from occupiers with difficulty, and given with the most evident reluctance and fear, and amidst entreaties not to expose

them; and indeed it stands to reason that the fouler the condition of any house, the greater generally will be the dependence of the occupier on the landlord, as such premises will scarcely be tenanted but by the poor, the outcast, and the improvident. Nor can we leave this subject without remarking that any such inspection as we have made must necessarily be of little value. Occasional inspection, when disease has broken out, is not what is wanted, but permanent inspection by persons living on the spot and properly authorized, having for its object the foreseeing and prevention of disease. The facts which we collected, after weeks of labour, from house to house, ought to have been ready to our hands on the first day that the cholera broke out; after the outbreak, every day which passes, makes the obtaining of evidence which can be relied upon, more difficult.

The resident clergy, with their staffs of lay-helpers, would in most parishes be able, and we believe willing, to give that valuable aid to the authorities for the purpose of permanent inspection. Such gentlemen as Mr. Whitehead, (from whose valuable work we have already quoted) and other clergymen whom we have met during this inquiry, would render invaluable and gratuitous help to the authorities if they were once put in the way of doing so.

We have the honor to be, Sir,

Your most obedient servants,

D. Fraser.
Thos. Hughes.
J. M. Ludlow.

No. V.

Memorandum on the Sanitary Conditions of Bethlem Hospital and of the City House of Occupations. By Mr. Lawrence.

An open piece of ground, between fourteen and sixteen acres in extent, in the parish of St. George, Southwark, is occupied by Bethlem Hospital and by the City "House of Occupations," two institutions which, although totally different in nature and object, are situated near together, and are under a common government and administration. They have the advantage of being surrounded on all sides by a clear space; and, having been erected expressly for their present purposes, are found to answer very well. Their ventilation and draining have been most carefully attended to, and their condition in both these important points is perfectly satisfactory.

The number of deranged persons in Bethlem has fluctuated of late years from three to four hundred; the latter number having been sometimes exceeded by twenty or thirty. They consist of three classes: curable patients, who quit the hospital at the end of a year, if then uncured; incurables; and criminal lunatics, who remain for an indefinite period, frequently for life.

The House of Occupations is an asylum and training institution for neglected, destitute, and in many instances criminal children of both sexes, who are instructed in various useful employments, and in reading, writing, and arithmetic, if they should not have already made those acquirements. They have three meals daily of plain but wholesome and nutritious food, the bread and beer being made in the establishment and of good quality. Beside active occupation in open, airy, and light workrooms, they have two or three hours open-air exercise daily when the weather permits. Personal cleanliness is strictly enforced, and all have a warm bath once a month.

They are admitted between the ages of thirteen and sixteen, and remain in the institution on an average about two years. The average number is from 210 to 220, sometimes more, sometimes fewer; and the two sexes are in about equal number.

When the resident officers, attendants, and servants are included, the population of the two establishments is about 700.

For some time after the Hospital and House were settled in the parish of St. George they were supplied by the Lambeth Waterworks Company. The water, which deposited an abundant muddy sediment was very bad, and hardly fit for use, the supply being also precarious and insufficient. The governors being determined to remedy this evil, caused artesian wells to be sunk on the premises, and all the water used in both establishments for every purpose is now derived from a boring carried to the depth of 220 feet. Nothing but this pure kind of water has been used for nearly thirty years.

There has not been a single case of Cholera in the Hospital or House of Occupations either in the two former epidemics of 1832 and 1849 or in the present, although the disease has prevailed extensively in the parish of St. George, and many cases have occurred in the streets most nearly adjoining the establishments.

It must, however, be observed that there have been cases of diarrhœa in both institutions in each of the three epidemics; and two or three have occurred in Bethlem within the last few days with a severity of symptoms justly entitling them to be called choleraic.

The new comers both in the Hospital and House exhibit almost invariably, within a short time after their arrival, a marked improvement in health and appearance. The inmates of the latter are singularly healthy, almost free from attacks of active or serious disease, not plagued with scrofula, and affording very little occupation to their medical attendant. Since the year 1830 there have been only four deaths among the boys, and five among the girls.

WM. LAWRENCE.

Whitehall Place, Sept. 27, 1854.

No. VI.

Memorandum on Asiatic Cholera and other Epidemics as influenced by Atmospheric Impurity. By Dr. Arnott.

1. In the year 1817, a destructive pestilence, now called Asiatic Cholera, sprang up near the mouths of the Ganges, and, spreading by human intercourse or otherwise, at last visited almost every country on earth, remaining in any one locality however only for a limited time, proportioned generally to the size or the population, but repeating its visits after irregular intervals of years. Because in its modes of attack and diffusion it differed much from other known epidemics, it at first excited unusual consternation, but observation has now clearly ascertained that the travelling morbific cause, whatever it be, can no more produce a true pestilence, unless it meet with much filth of decomposing animal and vegetable matters —of which air which has served for respiration is one kind—than coal gas can produce an explosion without being mixed with many times its volume of common air, or than sulphur alone can produce the effects of gunpowder when not mixed with the certain known proportions of nitre and charcoal. It thus appears that the ravages of Cholera may be prevented, by preventing local accumulations of organic impurities.

2. To many persons hearing this statement for the first time the reflection will occur that the laborious researches of medical men and others, in regard to Cholera, have detected many other things or conditions besides filth which exert powerful influence on the spreading and destructiveness of the disease; but a careful analysis of these particulars shows them all to belong to two classes, of which the one is of things which favour the accumulation of filth and its rotting or decomposition into foul effluvia, and the other is of agents which weaken the living system, and render it more susceptible of harm from filth or other cause. Of the first class are—

1. Whatever gathers filth or impedes its removal, as cesspools and imperfect drains.
2. Warmth (favouring decomposition).
3. Damp or moisture (with similar effects).
4. Hot, wet seasons.
5. Low river sides and sea shores; marshy levels.
6. Sea ports.
7. Crowds of people in houses, ships, &c.
8. Enclosed places without ventilation.
9. Calm weather, &c.

Of the second class, which weaken the system, are—

1. Intemperance of all kinds.
2. Debauchery.

3. Fatigue of body or mind.
4. Deficient food or long fasting.
5. Bad food, or drink, or air.
6. Depression of mind.
7. Uncomfortable dwellings.
8. Poverty, &c.

None of the particulars of either class, alone or combined, are in this country sufficient to cause Cholera, unless the epidemic influence which travels be also present.

3. Now the principal and in many cases the only source of the noxious impurities, above referred to, is the living body itself, converting into poisonous refuse the whole amount of the animal and vegetable substances which it takes as food. No portion of these substances is, according to the vulgar notion, altogether consumed or annihilated, but the whole is again, after a certain time, discharged from the system as excrementitious matter, solid, liquid, or aeriform, all these being then pernicious to health if used a second time. The fact is by many persons little suspected, that a very large part of the solid food swallowed is discharged from the lungs as invisible carbonic acid gas and other exhalation; the quantity of the solid carbon or charcoal element of food so escaping in twenty-four hours from a healthy man being from eight to twelve ounces. Now, even brutes, moved by instinct or annoyance to their senses, fly from or hide the refuse of their bodies, and men living together in civilized communities soon come to employ scavengers, drainage, &c., and other means to remove the more obvious impurities, while the wind, the warmth of the breath, and occasionally some artificial ventilation, aid in removing what is aeriform. In few instances, however, as yet have these means been rendered perfect.

4. The department of the art of cleansing, which remains the most imperfect, is that of ventilation. The reasons of this are,—that air, under common circumstances, is invisible; that scarcely 200 years have passed since scientific men suspected that air was at all a ponderable space-occupying substance, and only in our own day, since air has been used as stuffing for air-pillows, and one kind, with the name of coal gas, has been sold by measure from pipes, as water is, have people generally conceived of it as being truly a *thing;* that only about 100 years ago had even chemists learned that air or gas is not one unchangeable substance, but is one of the three forms called solid, liquid, and aeriform, which certainly many and probably all substances may assume under different degrees of heat, compression, and combination; that the particular substance, for instance, to which the name of *oxygen* has been given, since it was discovered by Dr. Priestly in 1783, which, in its separate state at the temperature of our earth, exists only as an air with which air-cushions may be stuffed, yet constitutes eight-ninths by weight of all the water on our globe, about a fourth of all the earth and stones, and a large proportion of the flesh and other parts of animals and vegetables; then men had not until lately reflected that solid or liquid filth in a house, if not swallowed in food or

drink, can be noxious only when it gives out part of its substance as foul effluvium to be breathed; and, lastly, men knew not that expired ordinary breath, which if inhaled again alone when recent or fresh may only suffocate by excluding fresh air, becomes, when stagnant or long retained in a place, in part, truly putrid or corrupt, as turtle soup or venison might change, and may then assume the forms of the different poisons which produce the gaol, the hospital, or the ship fevers, and other spreading diseases, or of that which, when joined with the peculiar morbid agents of small-pox, measles, scarlatina, or cholera, cause these to rage. Acquaintance with such facts, however, being once obtained, men can understand that ventilation is not of ordinary, but of paramount importance, for it can remove not only the breath poison of inmates, but also the foul air arising from all other sources, and so may act as a substitute for good drainage until there be time and opportunity to establish that. There is no liquid poison which may not be rendered harmless by copious dilution with fresh water, so there is no aerial poison of which the action may not be similarly influenced by dilution with fresh air.

5. It is important also here to remark that modern houses, since the introduction of close-fitting glass windows and of chimney flues with low openings for fire-places, have been rendered what persons ignorant of the nature of air could not suspect, namely, singularly efficacious traps for catching and long retaining all impure air or effluvium which may enter them from without, or be produced within them. Such airs, the exhaled breath for instance, being generally warmer and specifically lighter than the external air, are buoyed up towards the ceiling of rooms, where, if there be no outlet, they stagnate long, like oil floating on water, and are little disturbed by even copious streams of fresh colder and heavier air gliding along the floor from doors and windows to pass up the chimney flue. This truth is strikingly confirmed by such facts as the following:—the long time during which tobacco smoke, smell of dinner, and other odours remain in ordinary rooms; the fact that an ordinary bedroom, occupied by one or more persons, is, in the morning to a stranger entering it from the fresh air—a medical man, perhaps, called in urgency—always very offensive; that all sick rooms are usually thus offensive; that a person who in the early morning, before doors and windows have been opened, enters almost any house under the roof of which have been placed the foulest receptacles in nature—a closet with its cesspool and its drains, is forcibly struck by what is called the close disagreeable smell; the fact that many attacks of Cholera have occurred suddenly in the night, and even after calm sleep, in such closed houses, to persons who were apparently well when they went to rest; and, lastly, the important fact that the offensive atmosphere in all such cases is almost entirely prevented, or is quickly dissipated by an open window which admits fresh air to dilute the impurity, or better still by having an opening from the ceiling of the room into the chimney flue of a well-constructed fire-place, such as described in the paper on the smokeless

fire, lately published in the Journal of the Society of Arts, so that the strong chimney draught shall act as a constant air pump, withdrawing impurity from where it tends to accumulate. It may be remarked, that as a common gas pipe leaking into a close room, if undiscovered, soon converts the air of the room into the mixture of one part of gas and ten parts of common air, which in mines is called fire-damp, and is ready to explode at the instant of contact with a lighted candle, so a leak or source of impurity from drains, or crowded inmates in a close or unventilated room during a Cholera epidemic, may soon produce there what might be called Cholera-damp, ready on some accident to cause the outbreak of Cholera disease.

6. Effluvium from such filth as cesspools contain has, in past inquiries, been that most attended to, but there are many facts to show that the impurity of retained and corrupted breath, scarcely heeded in general, has been the chief element of the foul atmosphere which has led to numerous Cholera outbreaks. Thus, in England, it has been, in public institutions, clean to the eye, not very offensive to the nose, and where the inmates were well fed and well clothed, and otherwise well cared for under frequent public inspection, but where ventilation was overlooked and defective, that some of the most shocking scenes of destruction from Cholera have occurred; such was the school at Tooting, of 1,000 parish children, among whom about 300 cases of Cholera suddenly occurred, and killed more than half of those affected before the crowd was dispersed; and various union workhouses, lunatic asylums, prisons, &c., in London and elsewhere, were similarly visited; such places, in the end of 1849, produced more than half the cases of Cholera which then occurred, as is set forth (at page 37) in the very valuable Report on Cholera, drawn up by Dr. Baly and Dr. Gull, and issued by the College of Physicians. The very crowded school of the union-house at Taunton became a remarkable example, where thirty cases suddenly appeared in the room of the girls in which the glass of the windows remained entire, while in the adjoining room of the boys, where panes of glass were broken and fresh air was admitted, not a single case occurred; and there was only one other case in the whole town.

7. A large proportion of the facts set forth in the Report on Cholera above referred to, give strong support to the views here taken, as do also the details of other histories of Cholera wherever occurring. From the allied fleets in the Black Sea, late accounts have shown that Cholera had been much more destructive in the great three-decked ships, where the ventilation was more difficult, than in the ships of smaller size. In India, it has been found on several occasions, that in encampments where there was scanty accommodation, the putting an additional man into every tent has increased strikingly the mortality from Cholera. And almost everywhere, during attacks of Cholera, it has been found that the removal of persons from unventilated dwellings, in or about which were cesspools or other foul receptacles, to tents or other clean shelter on dry open ground has at once arrested the spread of the disease. The remarkable

fact that scavengers and night-men, whose common work is among the rankest filth, but almost always in the open air, have rarely been affected by the disease, indicates the power of dilution of a poison to render it harmless. Some of these men, however, occasionally, on penetrating into close unventilated drains, have narrowly escaped suffocation, and on coming out, have been attacked with violent vomiting and purging. This fact proves how rapidly aerial poison can enter the system to affect the intestinal canal, somewhat as in Cholera. Showing again, that even in the open air there may be concentration of poisonous effluvium sufficiently powerful to operate, Sir John Pringle, in his valuable work on the diseases of the English army which served in the Netherlands during the middle of the last century, narrates that in the camps and in warm weather destructive dysentery broke out among the men whenever they remained long in one place, and the privies became very foul; and that when fresh troops came to such a locality, great numbers were affected in the very first days.

8. With such facts in view as are set forth in the preceding paragraphs, all must perceive both the close dependence of men's health and well-being on the maintenance of purity of air within and about their dwellings, and the lamentable extent to which this object is missed in present ordinary procedure. The question, therefore, arises, Whether means can be placed within common reach of so diluting with fresh air and dispersing the copious aerial poisons generated wherever men live and work, as to render these impurities harmless? The answer to this question, it is hoped, may be given, that such means do exist, and that they are simple and inexpensive.

9. It might have been expected that the scientific men who first discovered the true nature of airs and their relations to the animal economy, would have been also the first to direct important applications of their knowledge to the preservation of the public health; but it has not been so. In this field of human exertion, as in many others, the tasks of purely scientific research and of the subsequent application of science to art, have been chiefly with different parties. It was not the chemist who first exhibited a jet of coal gas burning in his laboratory who also conceived and effected the noble feat of lighting up cities with gas, so as almost to convert night into day. It was not the persons who, ages ago, observed the expansive force of steam, and the sudden condensation of steam into water, effected by cold applied, who thought of turning its force to use, but it was left for James Watt, almost in our own day, to devise that wonderful combination of parts constituting the modern steam-engine, which has already spread a higher civilization over the earth. Then, for many a day, was the fact widely known that a shock of electricity travelled along a wire with the speed of lightning, before Wheatstone and others, who are still witnesses of their work, had constructed the electrical telegraph, which, with like speed, can deliver at any distance, and even make perfectly visible in writing or printing, any set of words forming a message committed to it. The application of

scientific knowledge to the effectual ventilation of human dwellings has yet to be rendered general.

10. To form just conceptions of what complete ventilation is, and of how it is in general to be accomplished, an inquirer has to consider that the ocean of air, called the atmosphere, which rests on the surface of the earth, and at the bottom of which men live, as certain aquatic animals live at the bottom of the sea, is about fifty miles high or deep, and that the portion of this ocean which can be contaminated by any process of animal or vegetable life, or by the decomposition of organic bodies when dead, may be regarded as less deep generally than the fiftieth part of one mile, estimated from the surface of the earth. This comparatively insignificant layer or stratum, therefore, may be regarded as the home or lurking-place of all epidemic and insalubrious influences, the more exact statement, indeed, being that these are generally confined to the still much smaller portions of air contained in houses or other enclosed places. Then the fact is to be kept in mind, that the whole mass of atmosphere at any moment over a city or other place is always travelling away to leeward with the speed of the wind, and is carrying with it whatever impurity may ascend from below, which impurity is then resolved quickly into the pure elementary oxygen, carbon, &c., of which all effluvia consist. Man can no more contaminate permanently the deep atmosphere over him by his proceedings at the bottom of it, than he can contaminate the Atlantic Sea by what he may do on its shores. Then he has to learn that with the same mechanical certainty as he can substitute the pure water of a passing tide or river stream for defiled water near the shore, he may substitute pure air from the atmosphere for any air near him that has become unfit for his use.

11. The incidents of the professional life of the writer of this Report, drew his attention early to the sanitary importance of ventilation and the regulation of temperature, and a familiarity with mechanical arrangements, increased while he was composing his "Elements of Physics or Natural Philosophy," suggested to him simpler and more effectual methods than had previously existed of obtaining, in many cases, the object sought.* The chief of these particulars, some of which are altogether new, and some are modifications of things or processes previously known, are—

1. That every house possesses in its common chimney flue, properly used, an admirably strong ventilating agent, which can establish sufficient communication with the free atmosphere above.

2. That for larger enclosed spaces, as public buildings, ships, &c., an air pump of great simplicity can be made, by which, at very

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* For part of these methods, since this Report was originally written, and in part read in the Medical Council of the General Board of Health, the Council of the Royal Society has awarded the author one of their medals. These methods are all in use, some of them extensively, with the expected results.

trifling cost of hand labour or other power, pure air may be supplied in any quantity, and by exact measure if desired, and with the same certainty and regularity as coal gas is supplied anywhere from ordinary gas works.

3. That in cold climates or seasons, hot foul air of any sort, in being discharged or pumped away from an enclosed space, can be made to give up pure warmth to the fresh air entering in its stead, one operation then accomplishing the two objects of ventilating and warming.

4. That for many purposes combustion within a closed stove may be rendered self-regulating and uninterrupted through nights and days, so as to diffuse all the heat obtainable from a given quantity of coal as uniformly as the contrivances of the candle or lamp diffuse the light which wax or oil can give; the stove referred to being also singularly economical or saving of fuel.

5. That by new and better arrangement of open fire-places, the common fire may be rendered smokeless, and be caused to save about half the fuel, although warming the room better than before, and further, may be insuring the complete ventilation referred to as the first of these five particulars. These advantages are obtained also with diminution of the danger, inconveniences, and watching service required about common fires.

12. In enumerating these improvements, the writer does not arrogate to himself greater penetration than other members of the profession to which he has the honour to belong, but attributes his success chiefly to the favouring accidents of his life. Dr. Jenner would not have left his name connected with vaccination if he had always lived in the centre of a great city, where fields and cows and dairy servants were not to be seen.

13. It remains to be observed, that even after practical applications of scientific principles have been devised, and their utility tested to the satisfaction of impartial judges, there is often much difficulty for a time in bringing the public to accept them. To agree in this, the reader needs only to recollect the ridicule at first, and then the more active resistance with which the early announcements of nearly all the important improvements of modern times were received; for instance, agricultural machines of various kinds, as the thrashing machine driven by steam, spinning and weaving machines driven by steam, gas lights, railways, steam navigation, the penny postage, and so forth, against all of which were brought to bear the attachment of men to the established customs of ages, popular ignorance of Nature's laws, strong misconceptions or prejudices directly opposed to the truth, narrow individual or class interest, &c., and if any failure occurred in early trials from the awkwardness or unskilfulness of workmen employed about what was new to them, it was charged as proof of errors in the principle. When at last, in spite of such opposition, a novelty was proved to be good, then, almost as certainly as flies collect about a little spilt honey, did a

host of dishonest men fall upon the novelty and its proposer, trying first to discredit the proposer, by saying the asserted novelty was not new and could not be the subject of a patent, and then often pretending that they had themselves invented improvements which might be so protected. By such opposition the full introduction of Watt's steam-engine was long delayed, and he had to defend his right by repeated suits in the law courts. Enlightened men, owing to the mass of absurdities, called new inventions and discoveries, which are constantly obtruded on public notice by ignorant and foolish projectors, have to use a cautious hesitation before acknowledging value in proffered novelties, but some of them even, have at first believed to be impossible certain new applications proposed of known means or principles, which have in the end been usefully established; for instance, Watt, Wollaston, and Davy at first gave it as their opinion that coal gas could not be safely applied to the purpose of street lighting. Others said that steam boats or ships could not safely navigate the great ocean. When Dr. Desaguliers, Dr. Hales, and others, a century ago, before oxygen and the nature of gases were known, proposed to ventilate houses and ships by mechanical means of certain action, instead of only by open windows and ports, they were regarded by honest persons in authority as visionaries. It is a curious and mixed instance, as related by writers of the time, that after Dr. Harvey published his discovery of the circulation of the blood, no medical man who had then reached the age of forty ever avowed his belief that Harvey was right.

Considering such facts, the writer of this, who has not restricted the public use of any of his devices by reserving patent rights, is of opinion that time will be saved and much public good effected, if the enlightened President of the General Board of Health, by his own authority, or by the direction of Government at his request, institute a commission of scientific men of known ability in regard to the matters here treated of,—medical men, chemists, and engineers,—to inquire and then advise specific procedure respecting them. Special scientific aid has already been afforded to the members of the medical council for other special objects. The award of the Royal Society above referred to will draw some public attention to the subject. The writer's own account of the new means soon to be published, will also have its effect, but a report and recommendations from such a special commission as referred to, if favourable to the measures proposed, would exert almost at once the influence of a law in securing willing obedience to any advice given.

N. Arnott, M.D.

No. VII.

Report on the Chemical Composition of Metropolitan Waters during the year 1854. By Dr R. D. Thomson.

WHEN an outbreak of cholera occurred in the autumn of 1854, spreading devastation into the heart of the metropolis, it was considered by the Board of Health advisable to institute an inquiry into the chemical condition of the water employed for domestic purposes in those houses where death had made the greatest havoc, and likewise into the state of the atmosphere surrounding the unfortunate victims. The object of this report is to present an account of the investigation which has been prosecuted in pursuance of the first of these intentions. It is not necessarily a part of the purport of this report to contrast the present water supply of London with other possibly superior sources. But the remarkable fact that the metropolis derives this necessary of life in great part from rivers and open canals, exposed to various contaminating influences—a species of supply which was rejected as unwholesome upwards of 2,000 years ago by the Samians and the Romans, and led those enterprising people to conduct spring water into their dwellings by means of the most stupendous engineering works—is well calculated to excite inquiry as to the cause of this retrograde movement in hygienic arrangements. The present experiments having insensibly extended so as to embrace the composition of a large variety of waters in the metropolis and in the provinces, many data will be here presented which may assist in forming a judgment as to the best sources of water supply.

In the year 1851 a commission was issued by Government for the purpose of obtaining an opinion respecting the chemical character of metropolitan waters. The gentlemen, however, to whom this duty was entrusted were not required to make any new investigations, but were merely desired to form a conclusion from certain documents which were submitted to their consideration. The printed data with which they were supplied seem, however, to have been so incomplete that new experiments were considered requisite to enable a conclusion to be drawn. But as this proceeding exceeded, apparently, the object of the commission, the waters of London were examined only on three consecutive days in January, after a fall of rain, the samples being taken from near the various companies' works, and with the cognizance, probably, of their respective engineers. The result of the analyses was to represent the river from Thames Ditton to Vauxhall as having the same chemical composition, or rather as increasing in purity in its descent towards the tide, since the water taken from the point of the river nearest to London was least contaminated with

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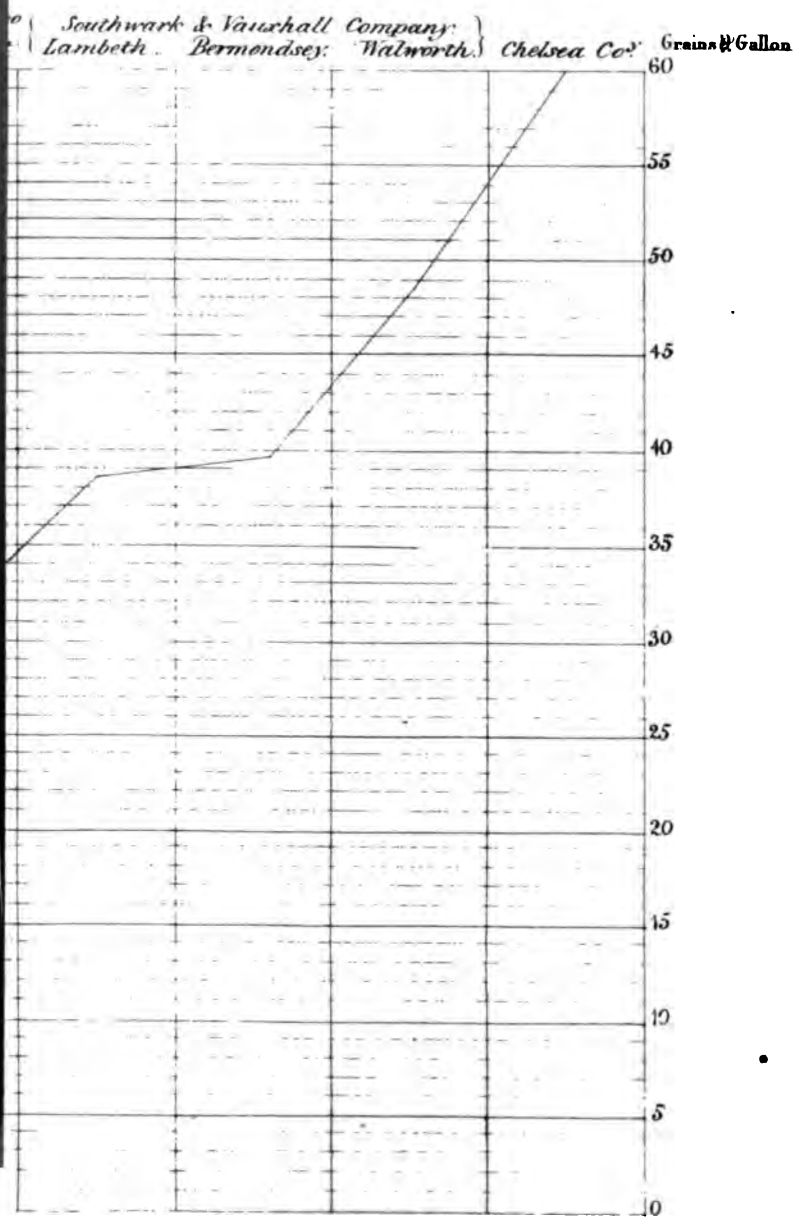

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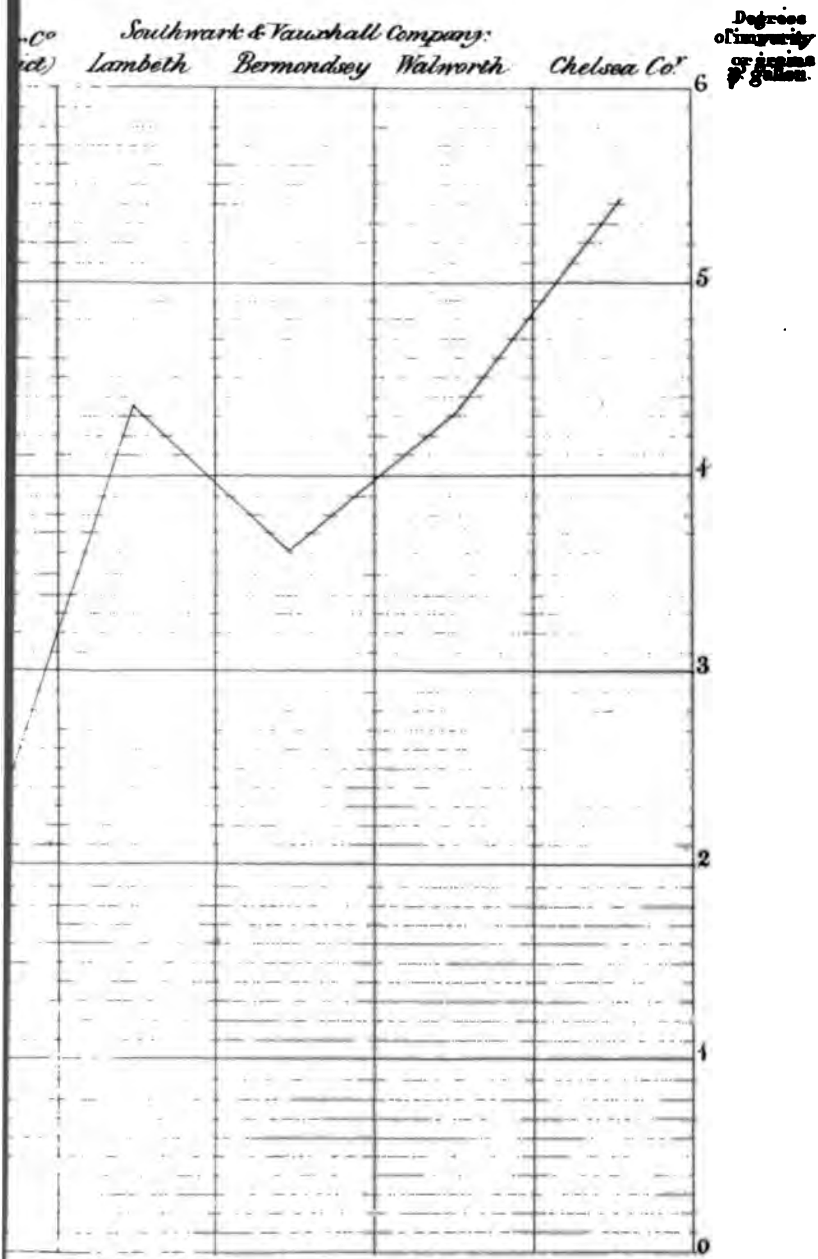

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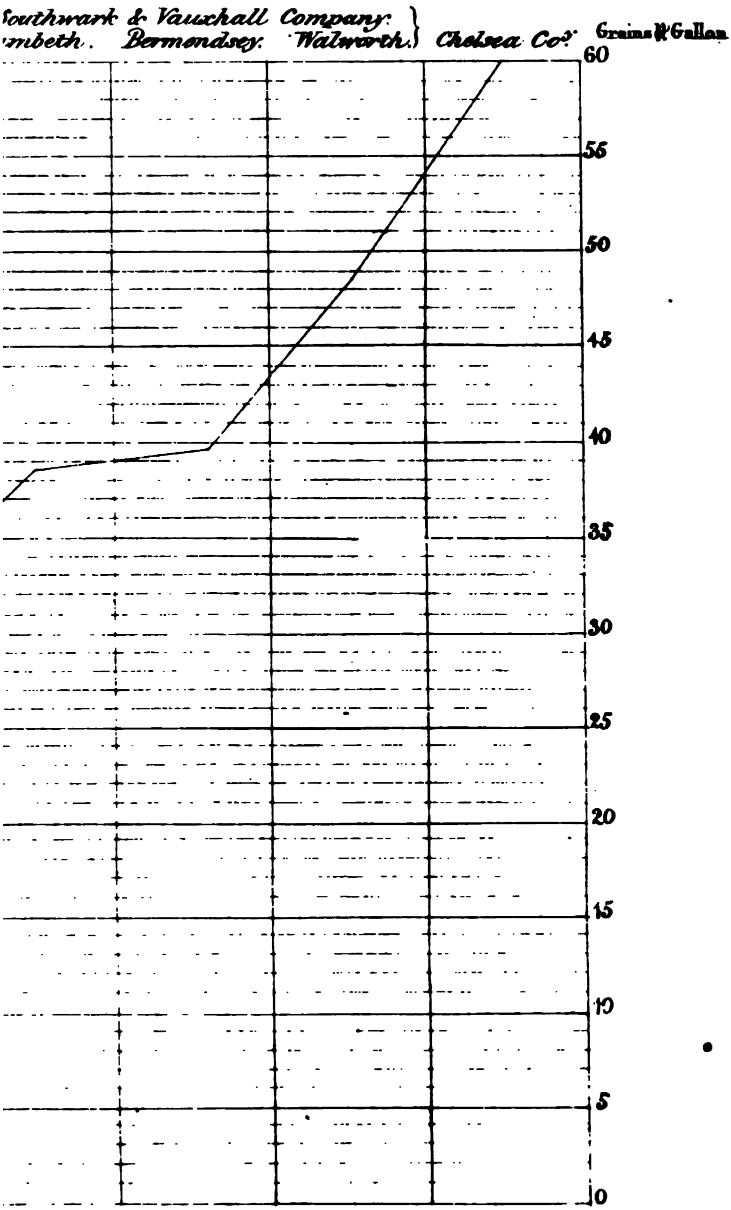

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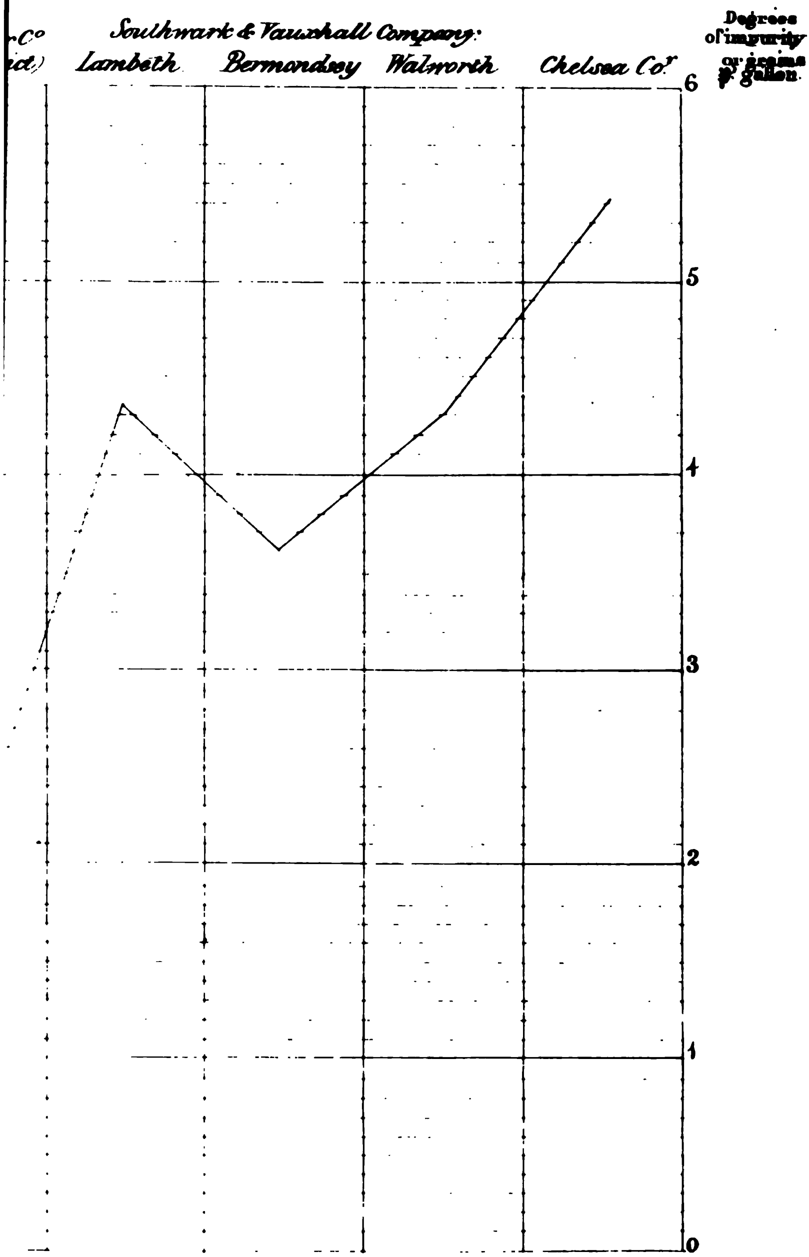

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foreign matter. The present inquiry, carried on during the greater part of four months, has led to a very different conclusion, and has shown that there is a very great disparity in the purity of the waters as supplied by companies from the Thames. The analyses contained in the report of the commission of 1851, must only be viewed as giving the composition of the waters after rain, and in certain cases afford a much more favourable view of the water than is borne out by the present report. The report of that commission does not profess to give any information respecting the condition of the waters in the houses of the consumers, but is confined to the analyses of the waters as delivered by the engineers. These remarks it was necessary to premise, in order that the cause of the material difference in the impurity of certain waters as given in that report, and as obtained in the present inquiry, may be sufficiently understood.

Impurity of Water.

An absolutely pure water is one that when boiled until it is entirely evaporated leaves no residue behind. Scarce any water has ever been found in nature to which this discription will apply. Even rain water, which may be viewed as the condensed vapour primarily distilled from the aqueous deposits on the surface of the earth, contains in solution gases, ammonia, and organic matter which it encounters in its descent. In London and its neighbourhood, rain water has been found sometimes to have an acid reaction, and to yield evidence of the presence of sulphuric acid to the appropriate tests. The source of this acid is obviously to be traced to the sulphurous acid emitted as a product of combustion, and diffused through the atmosphere, since it has been observed at St. Thomas's Hospital that when large quantities of air, derived either from the wards of the hospital or from the external atmosphere, are passed through distilled water, a strong acid reaction is communicated to that fluid. The acid condition of rain water affords a striking contrast with the alkaline qualities which it is described as possessing when it is precipitated from the heavens at greater distances from the haunts of men, as in Switzerland and India (Stark, Saussure, Laidlaw, McLelland). When rain water falls on the earth, it gradually dissolves *organic* matter and *inorganic* salts as it percolates the soil, and when during floods it is hurried over the surface of the land to be discharged into streams and rivers, it carries in a mechanical state of suspension much earthy and vegetable matter which alone can be separated by filtration. Rain water in the neighbourhood of the sea during a strong gale may be contaminated with common salt when sea water raised from the ocean in the form of spray is forcibly conveyed landward. It is to this mechanical method of carriage that is to be attributed the circumstance of the existence of traces of common salt frequently, as I have ascertained, in the freshly deposited rain on the summits of the Highland mountains, and in all the springs and streams at their loftiest and earliest origin on purely granite formations. It is to the same mechanical dispersion of common salt that I am led to attribute the injury inflicted on vegetation generally and strikingly on thinly

planted woods along our sea coasts Residents on the Atlantic shores are familiar with incrustations of salt on their windows during westerly gales of wind, results which have even been recognized at Manchester. Hence it will be noticed that it is the foliage next the sea which is the greatest sufferer, and that when trees are thinly planted, those most distant from the shore or most elevated are least deteriorated. The popular idea of sea air being prejudicial to vegetation does not appear in this aspect destitute of foundation; while the same circumstances may perhaps throw some light on the opinion of Hippocrates, that the characters of waters are influenced by the direction of the wind.

In this report it is proposed to represent distilled water, the only pure water, as the standard of comparison or basis of the scale of waters, and to designate it by the symbol 0° or *no degrees* of *impurity;* there being no grains of foreign matter in the gallon while every grain of matter per gallon, present in water will constitute 1° (one degree) of impurity. *Total impurity* will comprehend mechanical as well as dissolved matter; while *mechanical, organic,* and *inorganic* impurity will refer respectively to the diffused materials, to the vegetable and animal substances actually dissolved, and to the earthy and alkaline salts in a state of solution. The gradation of each of these species of impurity will be expressed in degrees, 1° denoting one grain per gallon of foreign matter contaminating the purity of the water.

Chemical Condition of the River Thames in the Metropolis.

As the river Thames is employed to supply upwards of 28½ millions of gallons of water daily to the inhabitants of the metropolis, and especially to districts where the epidemic raged with great fury, some attention has been bestowed on the condition of the river, not only at the localities from which the water supply is subtracted, but beyond these limits, for the purpose of detecting the marine and sewage sources of contamination. Table I. gives the composition of the river water, at high and low states of the tide, at Vauxhall, Hungerford, and London Bridge; the total impurity at high water being respectively at these places 102·42, 115·68, and 113·24 degrees or grains per gallon, while during low water the numbers were 27·14, 48·84, 32·08, and at Greeewich 95·68. The relative conditions of impurity are made obvious to the eye in *Diagram A.* The water was taken on each occasion from the river near the Vauxhall waterworks, at Hungerford Pier, at the Surrey end of London Bridge, and off the pier at Greenwich. To detect the existence of sea water in the fluid at high water, a determination was made of the chlorine which was respectively found to be at the three stations, beginning at the most westerly as above, 22 grains, 24 grains, and 24 grains per gallon, equivalent to 36·23, 39·53, and 39·53 grains of common salt. The source of this large accumulation of chlorine, which at Thames Ditton did not exceed during the investigation 1·36 grains, equal to 2·24 grains

common salt, must be sought for in the intermixture of the tidal waters. The results exhibit a marked distinction between the composition of the Thames at high and low water. The obstructing influence of the tidal wave appears not only to act as a barrier to the downward progress of the mechanical impurities so as to equalize the turbidness of the waters from Vauxhall to London Bridge; but it likewise causes the impure fluids from the sewers to accumulate, and imparts to the whole a retrograde movement, until rising to a tidal current, the sea and river waters are commingled. The greater impurity of the Hungerford waters in both conditions of the tide is sufficiently explained by the constant mechanical action at work at that point, and by the proximity of the locality where the water was taken to a common sewer which is there discharged into the river, and where a disgusting outflow continually occurs. The nature of the mechanical deposit falls to be described in the microscopical report. It is sufficient here to refer briefly to its chemical relations, premising that when magnified it presents the aspect of clouds of green organism, amid which lively animal motions can be discriminated. The February deposit at Greenwich, Table I., when dried in the open air, yielded above a fifth of its weight of organic matter, while in March the proportion was under a seventh; a large amount of the organic matter is in intimate union with the siliceous constituent of the diatomaceous beings which abound in the Thames waters. These bodies, when incinerated, undergo but a slight change in configuration, and leave siliceous shields, the framework of their organisms. The proportion of organic matter present in these beings is 12 per cent., the siliceous shields forming the remaining 88 per cent. according to my usual results. A certain quantity of mud, and often of feculent matter, is intermingled with the organisms, derived either from matter accompanying the water which has not yet subsided, or brought up from the bottom by the numerous mechanical agents unceasingly astir in the river; but the diatomaceæ, as found in the Thames, when carefully washed free from the mud and organic matter which usually accompanies them, yield on calcination a reddish siliceous ash, indicative of the presence of iron in their constitution. These general data being premised in relation to the chemical constitution of the river, as it flows through the metropolis, and as it exists in the neighbourhood of the localities where two of the companies (Southwark and Vauxhall company and the Chelsea company) abstract their supply for the use of large portions of the population in the western and southern districts of London, the conditions of the waters as occurring in houses will be more readily comprehended, and discrepancies between the present and former analyses sufficiently explained.

Metropolitan Water Companies.

The map published by the Board of Health exhibits the districts deriving their water from the respective water companies. The following table affords a view of the amount of water supplied by each company daily in 1853.

Thames Water.

	Gallons pumped daily.	Houses, &c. supplied.
Lambeth - - -	5,603,000	26,107
Grand Junction -	5,115,675	16,019
West Middlesex -	5,000,606	24,404
Chelsea - - -	5,632,000	24,729
Southwark & Vauxhall	7,287,289	40,046
Total Water from the Thames -	28,638,570	131,305

Other Companies.

	Gallons pumped daily.	Houses, &c. supplied.
New River - -	17,537,396	90,924
East London - -	11,990,989	63,605
Kent - - -	1,840,097	14,594
Hampstead - -	607,368	5,454
Total - -	31,975,850	174,577
Total daily supply from all sources -	60,614,420	305,882

But the subsequent analyses show that these waters contain a considerable amount of solid inorganic and organic matter. Reckoning the mean solid matter in a gallon at 27·5 grains, the total solids pumped by the water companies daily amount to 238,128 pounds avoirdupois, or 1·9 ounces to each inhabitant of 2,000,000. The amount of organic matter in the daily water supply at 3·07 grains per gallon averages 26,458 pounds daily.

1. *Lambeth Company.*—The highest point at which water is taken from the river is at Thames Ditton, to the neighbourhood of which, after the lapse of a short period, all the waterworks of the Thames are to be transferred. In Tables II. and IX. Lambeth water is placed first, as being derived from a point nearer than any of the companies to the source of the river, and hence containing a less amount of total impurity than is characteristic of the water taken at a lower point in the river's course to the ocean. This company supplies Lambeth and Brixton, &c.

2. *Grand Junction Company.*—This company derives its water from the Thames at Brentford, and is distributed towards Paddington and Westminster.

3. *West Middlesex Company.*—Descending the river the works of this Company are reached at Barnes, from whence it is distributed to Hammersmith, Marylebone, and the Regent's Park, &c.

4. *Chelsea Company* draws its supply from the river on the north

side opposite to Battersea, and is distributed to Chelsea, Westminster, and the neighbourhood of St. James's and Hyde Parks. The source of this water, as is obvious from the experiments detailed in this report in reference to the state of the river at high and low water. Table I., is thoroughly under the influence of the tidal wave.

5. *Southwark and Vauxhall Company.*—This waterwork, which is situated opposite to the Chelsea works, supplies Vauxhall, Clapham, Wandsworth, and Southwark.

6. *New River Company.*—The water of this Company is derived from the river Lea above Ware, and a variety of springs and wells partly discharged into the river.

7. *East London Company.*—The supply of this Company is derived from the river Lea at Lea-bridge and above Tottenham.

8. *Kent Company.*—This water is abstracted from the Ravensbourne below Lewisham, and is distributed to Deptford, Greenwich, and Woolwich.

9. *Hampstead Company.*—The supply is taken from springs at Hampstead and two artesian wells.

The object of the present chemical investigation being to determine with minuteness the composition of the waters used by the unfortunate individuals who had sunk under the influence of the epidemic, the specimens were generally taken from houses where the disease had numbered its victims. Many of the samples were taken in company with Dr. Hassall, whose microscopical examinations will, therefore, correspond in many instances with the specimens analysed in this report.*

Of all these waters it may be generally premised, in reference to the present investigation, that they were characterized by the formation of a deposit on standing, consisting principally of vegetable organisms mixed with abundance of animal life, when examined with microscopical assistance. Usually, however, in the Thames waters, on the scale of analysis which is commonly limited, the application of the balance was inadmissible for the quantitative discrimination of the mechanical residue. This remark does not apply so much to water extracted from cisterns, where the mechanical deposit can be often weighed, particularly during floods, but to water flowing in the distributing pipes. By the examination of the waters in both circumstances satisfactory evidence has been obtained that living growths exist in the waters supplied to the metropolis in the interval between the filter and the consumer, and, therefore beyond the influence of engineering talent to check or stay by the present arrangements. The conclusion seems inevitable that the waters of the Thames, even when purified as we may expect by the most delicate and refined adaptations of modern mechanism, still retain in their chemical constitution a condition which renders them fertile creative sources of vegetable and animal life.

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* Other specimens were collected by my assistant, Mr. Walker, and others were forwarded by the Board of Health.—See Dr. Hassall's report. For unremitting aid in the prosecution of this inquiry, I am indebted to my assistants, Messrs. David Walker and James Napier.

Districts supplied by the Lambeth and the Southwark and Vauxhall Companies.

The first district investigated was that of Lambeth, under the guidance of Mr. Mears, the district registrar, on the 5th of September, where the disease broke out and spread with great virulence. The groups of spectators encountered in the streets, conjoined with the mournful preparations that met the eye, spoke more powerfully than language, of the fell work of the destroyer. But the hospitable nature of the reception experienced by the deputation, and the hopeful anxiety depicted on the countenances of the parties visited, indicated expressively the gratitude of the people for the desire exhibited by Government to mitigate the bitterness of their sufferings.

This district is supplied with water from two sources, the Lambeth Company deriving their supply from Thames Ditton, above the influence of the London sewage and tide flow, and the Southwark and Vauxhall Company, abstracting their water from a part of the river where both of the causes of contamination mentioned are in full operation, as is demonstrated by Table I. and Diagram A. In several instances the names of the companies supplying houses were erroneously communicated on the spot, but no difficulty was experienced in correcting the inaccurate information by the chemical analysis of the waters, as will be obvious by an inspection of the data, Tables II., IV., IX., Diagrams B., C., D., expressive of the relative impurity and of their peculiar composition.

In considering the relative impurities of the water supplied to the Surrey side of the metropolis by these two companies, it is to be borne in mind that much of the district at present referred to is under the level of the river, rendering it thus liable to the gravitation of some sedimentary matter in the pipes, which would be less likely to occur under an ascending tendency of the current of distribution. As this influence operates on the organization of both companies, it may be viewed as a constant quantity to be added or subtracted from each supply, but increasing in a direct ratio with the mechanical impurity of each particular water at its source. It is certain, that during the period of the present investigation, water, whether drawn from cisterns or pipes of the Lambeth or Southwark Companies, always yielded a deposit on standing, but of largest amount in the water of the latter company. From Diagrams B. and C., the relative mean total and organic impurities of the two waters are rendered visible to the eye, while in tables II., IV., and IX., the details of these results as derived from various houses where the epidemic occurred, together with the number of deaths in each, are represented in parallel columns. From these data it appears that in nine houses in Lambeth and Walworth, where 14 deaths were occasioned by the epidemic, the mean total impurity (distilled water being 0°) in the Lambeth Company's water was 13·37 degrees (each degree being equal to one grain per gallon), the organic impurity being 1·43 degrees; while in an equal number of houses supplied by the Southwark and Vauxhall Companies, where 16 deaths and seven cases (still living when the water was taken)

occurred, the mean number of degrees of total impurity of the water was 46·09, and the mean organic impurity was 4·11 degrees. These data are not to be understood as affording a type of the relative mortality in the house supplied by the two companies; the houses having been indiscriminately entered during the prevalence of the cholera, rather with the object of convenience at the time than with any idea of selection. They, however, demonstrate, both as respects total and organic impurity, that the Southwark and Vauxhall Company afforded a necessary of life to the houses visited, which was three times more impure than that which was derived from the Lambeth Company's waterworks. These observations apply to the relative amount of foreign matters present in the several waters; but when we investigate the details of these total impurities, we shall also be enabled to detect characteristic distinctions (Table IX. *); for while ten substances are common to the constituents of the two waters, there is one ingredient, chloride of calcium, which is absent from the Lambeth water, while two, nitrate of lime and carbonate of ammonia, largely predominate in the Southwark over the amount of the same bodies detectable in the Lambeth water. In the Lambeth water the total amount of residue insoluble in water is 12·245 grains per gallon, and that of the salts soluble in water 3·585, the soluble matter existing in the ratio to the insoluble matter of 1 to 3·41. But in the Southwark water the ratio is reversed, for while the proportion of total Lambeth to total Southwark salts is as 1 to 2·4, or nearly twice and a half greater, the proportion in the Southwark of the insoluble to the soluble ingredients is 1 to 2·19. The usual characteristic of European rivers is the predominance in their composition of earthy salts, which are insoluble in water under ordinary circumstances. In the Rhine the insoluble salts are about $6\frac{1}{3}$ times greater than the soluble ingredients; while in the Rhone, the insoluble are double the soluble salts. In the Clyde, likewise, the ratio is as one soluble to nearly two insoluble matter. We have thus supplied to us a characteristic feature which enables us to distinguish a river water from one which is contaminated by matter from foreign sources. The existence of such a large quantity of common salt in the Thames water between bridges is sufficient to demonstrate, as has been previously pointed out, the commixture of sea water with the river current, as one extensive cause of the impurity of the Thames in this part of its course.

A peculiarity which pertains to Thames water as high at least as Chelsea, during the tidal flow, in common with sea water and the water of some wells, is the property which the saline residue obtained by boiling away the water possesses of fusing in the flame of a lamp or candle. It is sufficient to dip a moistened loop of platinum wire in the residue of Thames water derived below the western limit noticed, when it will be found to fuse with facility into a mass, and thus to afford a discriminating test from all genuine river waters with which we are acquainted, and certainly from all the metropolitan waters supplied by running streams.

By this test it was easy to distinguish Lambeth and Southwar'

waters. This character has been found to hold during the four months of the continuance of this investigation. But at certain periods of low water, the characteristics of river water may be recovered; the large amount of nitric acid and ammonia detected in the present series of analyses, has hitherto been greatly under-estimated in the Southwark water; particularly the ammonia, which has been obtained on such a scale and in such abundance as to warrant the conclusion that the influence of the sewerage upon the chemical character of the river Thames is much more extensive and unwholesome than was anticipated, although it points out this water as being admirably adapted for purposes of irrigation, since the numbers given in the table, which exhibit upwards of a $\frac{1}{4}$ grain per gallon of ammonia, and $\frac{5}{100}$ths of a grain of nitric acid per gallon, were obtained as an average of many trials, made after a fall of rain, and do not probably by any means represent the maximum amount of these substances present in the Southwark water during the driest season of the year. Experiments conducted on such a scale that the ammonia condensed and combined with sulphuric acid yielded, as the product of one operation, upwards of 50 grains of sulphate of ammonia, admitted of the easy demonstration of the abundance of ammonia in this company's water. The materials mixed with the water from which the ammonia and nitric acid are derived, are usually considered to be, in general language, organic matter, which is characterised by its containing the nitrogenous element for the production of ammonia. But when we investigate the nature of that form of animal matter which is discharged in great abundance into the river from which ammonia can with the greatest facility be elicited, we are led to the conclusion that it is the urea of urine which constitutes the most ready and the predominating source of this volatile compound; and that while ammonia is the first stage of the change of urea into simpler forms, nitric acid constitutes the second change, being produced under the influence of atmospheric air, which oxidizes the ammonia. Hence we find in almost every sample of Thames water the amount of nitric and ammonia to vary considerably, the difference in proportion being probably dependent, in a great degree, on the changeable nature of the tidal obstructions to the outflow of the sewage ingredients of the river water. It is thus necessary to be able to distinguish the source of the ammonia and nitric acid, since these substances, when mixed artificially in small doses in drinking water, could scarcely be designated as injurious to health, however objectionable they might be considered as foreign bodies impairing the purity of water. But their presence in Thames water is indicative of the constant mixture with the river of the most objectionable of all impurities, that of animal débris in various stages of decomposition. That the animal matter brought down by the sewers has not been wholly converted into the simpler and less noxious forms of ammonia and nitric acid, is obvious from the fact that in several trials made with Southwark water, nitrogen, the usual characteristic of animal and its identical vegetable prototype, was invariably found to be present in some solid form which was capable of solubility in water. This is an inference irrespective of the evidence, sufficiently palpable to microscopical observation, of

the presence of muscular fibre in the mechanical deposit from the same waters, as first observed by Dr. Hassall, which had certainly formed a part of the feculent matter derived from the teeming population of this great metropolis. The ammonia and nitric acid being viewed as the stages of transmutation of animal matter into less noxious forms, it appears probable that in the presence of much organic matter in waters, and of only minute quantities of ammonia and nitric acid, the objectionable character of water may be augmented.

When we take into consideration the facts that the Lambeth and Southwark Companies supply contiguous houses throughout the same district, that the elevation of their sites in relation to the river is identical, that the inhabitants supplied by both Companies are exactly similar with regard to means, and yet that the mortality in the houses supplied by the Southwark Company exceeded by nearly 2,000 the deaths that would have occurred, if cholera had only been as fatal as it was in the houses that derived their water supply from the Lambeth Company (Regis.-Gen. Weekly Report, 6th Dec. 1854), without viewing the subject in an extreme aspect, it is impossible to avoid drawing the conclusion, that the Southwark water must at least have had a more predisposing influence in the production of the disease than that of the Lambeth Company. It does not appear that sufficient data exist to enable us to decide as to the peculiar nature of the influence in the production of the disease communicated by impure water to the human system. Whether it be the seeds of the disease existing in the water, according to an old and very prevalent oriental theory, or whether by the access of other local and general influences a predisposition to the lodgment of the epidemic is engendered in the animal frame by the use of water tainted with organic matter, are uncertain, although it is just possible that the conditions under both hypotheses, when certain circumstances prevail, may influence the production and communication of the epidemic.*

The latter view seems most reconcilable with a general survey of the cholera as it occurs in different localities and climates. The facts connected with the occurrence of cholera on river margins have been elaborately urged by Dr. Snow in favour of the Indian theory, while the same circumstances have been most ingeniously applied by another theorist to the use of autumnal stores of unsound flour. The law of elevation, however, established by Dr. Farr, takes cognizance of such facts and affords a general view of the subject. Exclusive theories are objectionable on the ground of their overlooking circumstances of moment, not only in regard to theory but even in respect to the practical management of the disease. The oriental and farinaceous theories will receive the acquiescence of all, in so far as they condemn impure waters and decomposing flour. There are some instances, however, on which, so far as the evidence before us leads, the disease appears to be propagated entirely by atmospheric media. The appearance of cholera in St. Kilda without any known communication with the main land, has been cited by Dr. Robert Macgregor, of

* Analogy leads to the inference that a morbid organized poison cannot both act by intestinal and by pulmonary absorption.

Glasgow, as one of those otherwise inexplicable phenomena. In reference to the connexion of tainted atmospheres with the propagation of disease, the insufficiency of the drainage in the district now under consideration could not fail to be forcibly impressed on the senses of the inquirer. In many instances it was found that no communication existed between the houses and the sewers; and frequently when a house drain did terminate in the sewer, the original cesspool remained, so that a well of garbage and excrementitious filth, extending its domains in every direction by infiltration, constituted a never-failing source of pollution to air and soil—the overflow alone escaping to the sewer. That the contents of cesspools permeate the surrounding media like a sponge, has been abundantly illustrated even in the comparatively more healthy portions of the metropolis, where wells reeking with organic odours have been chemically examined and condemned as noxious to health. The water from a well on the hill at Camberwell, used by a family where much delicacy had occurred among the inmates, when it reached the laboratory of St. Thomas's hospital emitted a disgusting smell resembling that of putrid cabbage (Table of Wells) and contained no less than 16·63 grains of organic matter, nitric acid, and ammonia in the gallon. On filling up a cesspool with which the well had previously been in communication, after six months interval it still contained 7·26 grains of similar matter per gallon, although no smell was perceptible.

It might appear on a cursory examination that the circumstance of cases of cholera occurring in houses supplied by the Lambeth Company militates against the possible influence of impure water in the promotion of disease. But when it is borne in mind that the Lambeth water is by no means a pure form of that fluid, as is obvious to the eye in diagrams B. and C., representing the impurity of various waters supplied in many towns in England and Scotland, being from a third to a half more impure than the river Clyde, which has been discarded by the inhabitants of Glasgow as a proper source of supply, and equally more impure than the water used in Paris from the Seine. The water of the Lambeth Company, as has been previously stated, is abstracted from the river at Thames Ditton, after it has served as a sewer for an extensive country, well manured and studded with towns, which are occupied by a numerous population, continually on the increase. This water was found to contain ·023 grains of ammonia per gallon, which is equivalent to ·064 grains of carbonate of ammonia; a strongly presumptive evidence of the contamination of the river, even at this part of its course, with organic matter, independent of the solid organic matter actually detected in a state of solution in the water. It is, consequently, a subject of much regret that the water companies should have embarked a large additional amount of capital in improving their mode of supply exclusively from a source of objectionable character, and subject to continually augmenting means of deterioration.

District supplied by Grand Junction and New River Companies.

On the 31st August and 1st September the epidemic broke out with great virulence in the neighbourhood of Golden Square, Soho,

and spread with a fatality scarcely exceeded by the mortality of the plague, as described by the romantic pen of Defoe. The number of deaths from cholera in this limited district in six weeks exceeded 600. The fatal character of the disease on the 9th of September, when the samples of water were taken, had become extensively known, and had produced such alarm among the residents that the greatest gloom pervaded the locality from the suddenness and almost explosive nature of the attacks. Specimens of water were taken from five houses supplied by the Grand Junction Company, in which 15 cases of cholera had occurred, and from seven houses supplied by the New River Company where 40 cases of cholera and diarrhœa had prevailed. The pump water in Broad Street was also preserved for examination. On analysis it was soon evident that the water supplied by the New River Company presented a remarkable anomaly, for when subjected to examination in 1838, I did not find the New River water to contain more than one half the impurity which the present specimen exhibited. It was therefore considered of importance to compare it with samples derived from the New River Head. The results of the determination of the relative degrees of impurity in these two examples are illustrated in Tables VI. and X., where the water from the reservoir was found to possess a mean of 16· degrees of total impurity and of 1·51 degrees of organic impurity, while the water from the Soho district, supplied by the same company, had a mean total impurity of 28·64 degrees, and of organic impurity of 1·98. That no doubt might exist as to the true source of supply, I was empowered by the Board of Health to obtain the assistance of the registrar of the district, to visit the houses and see the water-rate receipts. This was done in all the houses said to be supplied by the New River Company. The table has, therefore, been constructed from this information. From the table it will be found that this greater degree of impurity was not confined to the period of the prevalence of the epidemic, but continued up to the subsequent November, when it was again subjected to examination, and compared with water taken from the reservoir at Sadler's Wells on the same day. It is, therefore, demonstrated that the water professed to be supplied by the New River Company to a portion of the district examined, was totally different in its chemical character from that contained in the Company's reservoir at Sadler's Wells. Another peculiarity, in addition to the much greater amount of saline residue, is detected in the character of the matter in solution, which renders it comparable with Thames water. The salts were found to be easily fusible when their quantity greatly exceeded that of the reservoir samples, and infusible when they approximated the weight and normal condition of the usual water supplied by the Company. In the Diagram B. it becomes apparent to the eye, that the New River water supplied to the Soho district approaches the same category of impure waters, as the most impure of the Thames waters.

The proportion of organic matter present in it, likewise, is in comparative excess in the relation of 100 in the reservoir water to 131 in the water of the Soho district. It was at first suspected that the water was derived from the Thames, from which it is understood that

at one time this company obtained a partial supply, but the chemical analysis rendered this improbable (Table X.), from the difference in the constitution of the saline ingredients. These and other circumstances have led to the inference that the supply may be derived from one of the numerous sources possessed by the New River, before being diluted with other purer specimens of their waters. It deserves remark, too, that this anomaly in the water could only have been detected by a minute chemical investigation of the details connected with the local occurrence of the epidemic, and supports the propriety of the specific inquiry set on foot by the Board of Health, instead of trusting to a general superficial survey.*

The remaining houses examined derived their water from the Grand Junction Company. It left comparatively a smaller amount of residue, but contained rather an excess of organic matter (3·78 degrees), particularly when compared with the amount present, 1·92 degrees, in November, as detailed in Table III. The only other source of water in the district is that of wells, one of which, in Broad Street, when examined, was found to contain 92·06 degrees of impurity or grains per gallon, of which 7·8 were due to organic matter, nitric acid, and ammonia; but the organic matter seemed to have but recently reached its destination, since from the absence of much nitric acid oxidation had but slightly commenced to change its form. It is scarcely possible to condemn in too strong terms such a source of supply of water as a shallow well in a great city, which chemical and physical examination universally proves to be a pool of water deriving its contents from the oozings of fluids from cesspools and sewers, mixed with rain water, and holding in solution more or less of all noxious soluble filth contained in the soil. That cesspools predominate to a great extent in this district was ascertained by inquiry. For notwithstanding the large amount of new sewerage lately completed in this locality, and executed with great skill, it does not appear that the house proprietors have availed themselves of the advantage thus presented to them of improving the sanitary condition of their properties by carrying off the house refuse into the sewers; since, if I am correctly informed, only a small per-centage of the houses has any communication with the sewers. When, too, drains have been executed, it appears that in many instances the original cesspools still remain, and it is only the overflow which passes to the sewers. This is an evil which seems to demand searching inquiry, and to be provided against by stringent means, otherwise an immense expenditure may be incurred and talent wasted in the construction of sewers, without any adequate advantage to the health of the community. The sewage water in Silver Street, Golden Square, when examined, was found to hold in suspension much organic matter, and to leave a residue by evaporation of 88·68 degrees or grains per gallon, of which 26·88 consisted of organic matter. The fluid contents of the sewer in Peter Street gave 48·98 grains of residue per gallon and 4·8 grains of organic matter,

* I have since been informed by Mr. Mylne, engineer of the New River Company, that this district is supplied from two sources, the New River head, and a well in the northern part of the metropolis. Their intermixture by lateral communication explains the variable conditions of the Soho district water in the table.

while in Husband Street it was found to yield 58·6 grains of residue, including 6·04 grains of organic matter. The fluids possessed a most abominable odour, and decomposed or fermented most extensively when preserved in close vessels, sulphuretted hydrogen constituting a part of the gaseous exhalations. It is a circumstance of some moment that during several years connexion with the Blenheim Street Dispensary, to which charity I acted as physician, (and of which I was one of the founders in 1836,) a large number of patients came from this locality affected with epidemics and diseases indicative of a low state of cleanliness and civilization.

Water supplied by the Chelsea Company.

In the district of Chelsea, particularly in the southern part, cholera prevailed to some extent. The mortality being 60 per 10,000 inhabitants, a fatality very considerably in excess of the mean (45 per 10,000) of the western metropolitan districts. Water was collected from four houses, in which 12 deaths and seven additional cases of cholera had occurred. These waters, which were all supplied by the Chelsea Water Company, were proved by analysis to have a very high standard of impurity, the mean degrees of impurity being 60·17, (Tables V. and IX.), the maximum impurity being 65·66, and the minimum 50·4 degrees. The average thus obtained is much above the mean of the Southwark and Vauxhall Company's water; but the circumstance that it is derived from a more limited series of data must be taken into consideration; although the fact remains intact that the average impurity of Chelsea Water in cholera houses greatly exceeded that on the Surrey side of the River under similar circumstances. The mean of organic impurity is also decidedly greater in the Chelsea water, 5·41 degrees, than in the Southwark water, 4·38 degrees. To determine if the impurity of the Chelsea Water remained permanent, a specimen of water was examined from one of the same cholera houses, long after the cholera had disappeared from the neighbourhood (8th December), when it was ascertained to be 36·96 degrees, approximating to that of the Southwark Company, 38·72 degrees in September, during the prevalence of the epidemic in the Lambeth district. But the data supplied by Table I., diagram A., of the variable composition of the Thames water at the sources from which the Southwark and the Chelsea Companies are derived, sufficiently attest the dependence of the chemical results upon the condition of the tide at the time during which the water is abstracted from the river, and likewise demonstrate that neither of these waters is always drawn when the river is in its most favourable sanitary condition. The great discrepancy between the mortality in the Southwark and Chelsea districts, notwithstanding the greater impurity of the Chelsea water, shows that the condition of the population in regard to drainage and physical conformation, must be regarded as well as the water in connexion with the epidemic.

Districts supplied by East London, Kent, and Hampstead Companies.

The water supplied by these companies possessed respectively the following degrees of impurity, viz.,—East London, 18·3 total degrees

of impurity; organic impurity, 1·97; Kent water, 17·76 total impurity; 1·66 organic impurity; Hampstead, 24·22 total impurity; 3·88 organic impurity. The East London alone was taken from houses in which cholera had occurred. The greater tendency to the production of animalcules in the water of open exposed streams or canals, places certain springs which are not liable to lateral infiltration of impurities in a more favourable position, as far as the peculiarity of the ingredients is concerned, although they possess the disadvantage of exceeding in total impurity. So far as the water could have any influence in the production or propagation of cholera, the Hampstead water contrasts favourably with the East London and Kent districts, for while in the Hampstead district the mortality was only 12 per 10,000 in 15 weeks, that of the East London in Bow and Poplar was 42 per 10,000, and that of the Kent a mean of 48 per 10,000. The greater mortality in the Deptford and Rotherhithe districts is probably referable to the low position in reference to the river (+ 4 feet, and below the river level), and to the contamination of the air by the noxious exhalations emanating from an imperfect drainage. The marshy condition of the river side downwards is undoubted while the stagnating débris of a large population cannot fail to act prejudicially to human life. The influence of want of drainage, and the accumulation of organic fluids, is well illustrated in the Plumstead marshes, where stagnating waters, disgusting from their noxious odours contain above 102 degrees of impurity, and 20 degrees of organic impurity, which is accompanied with nitric acid and ammonia, all symptoms of the presence of putrefying animal matter. To form a faint notion of the unhealthy position of those parts of London placed beside the river, and beneath its level, we have only to imagine a town built on the Plumstead marshes, its subsoil thoroughly impregnated with decomposing organic matter, and deriving a plentiful accession of additional filth from the continually increasing deposition of débris from animal life.

ROBERT DUNDAS THOMSON, M.D.

London, St. Thomas's Hospital,
15th Jan. 1855.

Report on the Chemical Composition of some London and Provincial Wells.

Having taken no inconsiderable share in pointing out the objectionable nature of well waters in towns for domestic use, it may be premised that my attention was especially drawn in 1845 to the detection of nitric acid in them and in other waters by Baron Liebig, who had many years previously directed much attention to the subject. In 1751 Margraf, of Berlin, had obtained nitric acid in the wells of that city, but was unable to detect it in country wells. In 1825 Liebig confirmed the experiments of the Prussian chemist, and traced the origin of the nitric acid to the organic matter of towns. Saussure in the beginning of the century detected ammonia in the atmosphere, while Dabit obtained it in the distillation of river water in 1805. In 1845 I happened to be engaged in examining many of the tributaries of the river Clyde, for the purpose of fixing on a proper source of supply for the city of Glasgow. Professor Liebig, who visited me during the period, suggested the propriety of testing the waters for nitric acid, but having failed in discovering it in running streams near their source, on the scale of analysis to which I was necessarily confined, I tried for it in the Glasgow well waters with completely successful results, and ascertained that nitric acid occupied a much more prominent position in the constitution of these waters than could have been anticipated from any researches previously made public on the subject. In 1847 it was proposed by some parties in Glasgow, from benevolent motives, to sink new wells in that city, in order that the working classes might have a plentiful supply of water gratuitously, and a considerable sum of money was upon the point of being expended by the Town Council on this object. But on the facts being laid before them as to the impurity of well waters, the project was speedily abandoned. The report made to the Council on the constitution of the wells was published by them, and drew the attention of other towns to the presence of human excretions in well waters. Table XV. contains the results of the examination of the total degrees of impurity of 18 Glasgow wells. In some of these the nitric acid amounted to not less than 3·64° and 3·48° grs. per gallon, while the total impurity ranges from 99·5° to 14·9°. In the beginning of 1850 the corporation of Liverpool requested me to examine the wells of that city, from which the whole water supply of the inhabitants was derived. In the waters of all the 21 wells examined nitric acid was readily detected. Table XV. likewise affords a view of the total degrees of impurity in these wells. In the case of the most impure of the Liverpool wells, which is situated at a distance of 1,050 yards from the River Mersey, the water when I visited it tasted quite brackish and was unfit for drinking, but

I was assured by the workmen on the premises in which the well is sunk that they used it as a beverage a few years anterior to my visit. This and other facts have shown that in a pervious soil the removal of surface water from it by pumping leads to lateral permeation by the tide to replace the water thus withdrawn from between the particles of the soil in which it was contained: and that in proportion to the rapidity with which the well water is abstracted, so is the influence of the tidal current detected in the well waters. It is almost unnecessary to remark, that when water can be thus proved to permeate a soil laterally for the distance of 1,000 yards, still less difficulty will be experienced in the filtration of noxious fluids from more approximate sources of impurity, such as cesspools, &c.; and it will then be understood that city wells are, practically, reservoirs into which all soluble surface nuisances drain. The variable nature of the chemical composition (Table XII.) of London wells, proves that the ingredients of the same wells at different periods vary to a very considerable extent. Thus, Aldgate pump, in January, was characterized by 49·12° of total impurity, and 13·94° of organic impurity, while in February these numbers were respectively 44·64° and 6·3°. The remarkable impurity of the Putney wells, 180·4° and 101·3° of total impurity, and respectively 16° and 14° of organic impurity, is sufficient to indicate the proximity of some noxious sources of contamination which render the waters unfit for animal consumption. That the use of such infusions of filth by the population is not instantly followed by death, is undoubtedly the cause of perseverance in much inattention to hygienic foresight. But experience must point out to us that, even reasoning on the theory of probabilities, a pure beverage is less likely to prove unhealthy than one which contains in solution the most naturally disgusting and unwholesome of all matter to human beings, viz., the excretions from their own bodies. To the chemical physiologist, it is impossible to view the employment of such beverages otherwise than as an infringement of sanitary laws, and therefore as liable to natural punishment. It has been correctly observed, "that such and such miseries naturally follow such and "such actions of imprudence and wilfulness, as well as actions more "commonly and more distinctly considered as vicious;" and, "that "though we may imagine a constitution of nature in which these natural "punishments, which are in fact to follow, would follow immediately "upon such actions being done, or very soon after, we find, on the "contrary, in our world, that they are often delayed a great while, "sometimes even till long after the actions occasioning them are "forgot." (Butler's Analogy, chap. ii.) The terms *springs* and *spring waters*, by which these filthy infusions are often designated, seem to modify in some measure their impurity, by throwing a rustic halo around them, and assimilating them in language, though in words alone, to their purer prototypes, which are situated at a distance from liability to noxious impregnation. This would be found to be the great obstacle to the success of the attempt to supersede the use of impure well waters by the more healthy supplies. Voluntary recommendation seems to have failed in causing these sources to be abandoned, and therefore we must look to the more stringent means

of shutting up waters of such an impure nature, and all other similar objectionable articles of food, on the score of regard to the health of the least protected portion of the community. It must be viewed at least as a striking coincidence, that the cities of Liverpool and Glasgow, in which well waters are very extensively employed by the population, are precisely the localities where cholera has assumed its most fatal phase; and it is not probable, when experience points out the unacquaintance among the more educated classes with the impurities of human food, that the more illiterate class should cease to employ tainted waters so long as wells are open gratuitously for their use. The legislature would confer great benefits on health by causing the poor to be freely supplied with water from the purest sources by means of a house rate or some similar provision.

When Newcastle was visited in 1853 by a remarkably fatal invasion of cholera, the coincidence of the occurrence of the disease with the use of impure water from the River Tyne, formed a striking fact in the history of the epidemic. The local statement which was made at the time, that the troops in the barracks, who were said to be supplied with *pure spring water,* and were severely attacked by cholera, seemed deserving of investigation in its chemical relations. On the outbreak of the disease I examined the water of the river for the Board of Health, taken from the point at which it was pumped by the Water Company from the Tyne at Elswick two or three hours after low water, and found it to be characterised by 15·662 degrees of total impurity, of which 4·5° were due to mechanical impurity, 2·68° to organic impurity in solution, the remaining 8·48° consisting of inorganic impurity. The data which have been supplied in reference to the condition of the River Thames (Table I. Diagram A.) are sufficient to indicate the relative impurity of river water influenced by town sewage at high and low states of the tide. The constitution of the Tyne is not therefore here represented in its most exceptional condition. On the contrary, reasoning from analogy, we should infer that it was nearly in its purest form. To ascertain whether the statement made was correct, that the *spring water* used by the military was *pure,* a quantity was sent to me for analysis; upon examination it was found to possess 100·56 degrees of impurity (or grains of foreign matter per gallon), of which 15·052° were due to organic impurity, including abundance of nitric acid, and 85·5° of inorganic impurity. It was therefore evident that the statement of the water being *pure* and being *spring water* was a fallacy, and that the so-called spring was merely one of those familiar wells, or pits as they should be termed, which in towns serve as reservoirs for the drainage of soluble surface filth. After the termination of the epidemic at Newcastle, it was observed from the returns that diarrhœa, and not cholera, was the prevailing disorder among the troops; and this was used as an argument in favour of the advantage of *pure spring water* over impure river water, in checking the progress of the preliminary symptons into the more advanced stages of Asiatic cholera. Although these remarks apply peculiarly to shallow wells, much organic matter often accompanies in solution waters arising from great depths in the form of Artesian

wells. A spring of this description in the neighbourhood of Glasgow, which contained 40·5 degrees of impurity or grains of residue in the gallon, possessed nearly 2 per cent. of organic matter, which was deposited in such quantities in pipes through which it was conducted, on rising from a sandstone stratum at a depth of above 1,000 feet, that they speedily became choked up and unfit for use. But the amount of the organic matter varies very considerably in shallow wells at different times. The same observation applies to the amount of impurity both organic, and inorganic, as is observable in Table XV., where the impurity of Glasgow wells is exhibited. Nos. 6 and 7 indicate for the same well in two consecutive months 58·84° and 66·2°, and Nos. 13 and 14 likewise another well in succeeding months 50·64° and 43·24°. In the Liverpool wells, too, where the water has less time to accumulate and concentrate saline matter, in consequence of the town supply being derived entirely from them, we observe Nos. 9 and 10, Table XV., that Bevington Bush in January contained 48·63° of impurity, and in February 45·90°. These results, therefore, agree with the previous remarks which have been made in this report as to the variable character of the constitution of the London shallow wells. But these conditions of the shallow wells seem to afford a striking contrast with the waters of Plumstead and Watford, Nos. 14 and 16, Table XIV., derived from fissures in the chalk, which appear to retain a steady composition, thus showing that they are not subject to sudden mixture with impurities, but that their source is rain-water, which permeates slowly and regularly to a great depth, strata which yield up to each successive portion of water, as it descends, the same soluble ingredients. Thus, I found the Watford water to contain 22·4° of impurity, a number identical with that obtained by the Commissioners in 1851. This character of stability is one of the most important in reference to an article of human consumption, since an alteration in the amount or variety of the materials dissolved in water must always indicate its connexion with some uncertain source of supply, and therefore a liability to contamination by unknown impurities. Well water derived from a considerable depth is usually cool and clear in summer, and it is from these characters that in London it is chiefly valued. It is obvious that coolness might be equally communicated to a pure water by immersing closed bottles filled with it in wells, or by the application, as customary, of ice or cooling refrigerating mixtures. The most impure of all the wells which I have examined was No. 1 (Table XII. 20), from Newton, Wisbeach, possessed of 48·176° of total, and 49·6° of organic impurity, with 3·2° of mechanical impurity. No. 2 (Table XII. 21), from the same locality, had an impurity of 348·8°, and 21·6° of organic impurity, with 9·33° of mechanical impurity. It will be observed in these instances that no idea of the total matter in solution could have been anticipated from the amount of sediment. And the same observation applies to a well water from Mill Corner, Hadley, (Table XII. 19,) whose mechanical impurity was 37·81, and the total impurity in solution 83·2°, the organic impurity being 27·6°.

Hardness of London Waters.

The hardness of water, so readily distinguishable when water possessed of that property is subjected to friction between the fingers, is a character of importance in reference to domestic purposes. The property of hardness is most readily apprehended when we compare sea or well water with rain water; and when hard water, detected by the sensation communicated to the fingers, is mixed with a solution of soap in distilled water added drop by drop, a precipitate is observed to fall or curdle, which increases, in proportion to the amount or degree of hardness. When we examine the precipitate, which is insoluble in water, it is found to consist of the acid of the soap united with lime and magnesia, previously existing in solution in the water. After the cessation of precipitation, if we filter the water we shall find that it no longer produces the harsh sensation when rubbed between the fingers, but that the removal of the lime and magnesia has deprived it of its hardness. One of the results then, it is obvious, of the hardness of water, in other words, of the presence of earths in solution in water, is to waste the first portions of soap which are added to it when hard water is used for the purposes of washing; and it is likewise evident that, by taking a solution of soap of a given strength, and adding it cautiously to a given quantity of water, we are in a condition to estimate the hardness of the water by the amount of soap solution required to be added before the new precipitation or curdling ceases. The relative hardness of water might therefore be expressed in numbers by the amount of soap consumed by each. But as this quantity might be liable to some variation, it has been agreed, at the suggestion of Dr. Clark, to denote the hardness by the amount of lime and magnesia which causes the curdling of the soap, and to speak of degrees of hardness, each degree of hardness being equivalent to one grain of carbonate of lime per gallon present in the water, distilled water being 0°. Table XI. and Diagram D. give the relative hardness of the waters supplied by the Metropolitan Companies during the period when the analyses detailed in this report were made. From these it appears, that the Chelsea water was the hardest, or 18·4°, and the anomalous water supplied by the New River Company to Soho was the softest, or 9·6°. The mean hardness of the Metropolitan Companies' waters, omitting the Chelsea Company and the Southwark and Hampstead Company, is 13·1°; including the Chelsea and Southwark Companies, it is 14·4°. Judging from preceding investigations in reference to the hardness of the London waters, it appears that they are rather softer in dry weather than after rain, which appears to carry down the calcareous salts into the river in those districts where these substances predominate. One great objection to the use of hard water by a community, is the expense incurred in using it for washing by the waste of soap sustained in the manner already detailed. That this is an important consideration will be readily understood if we take the estimate as correct which makes the amount of soap consumed in the metropolis annually exceed in value half a million sterling, and the washing bills alone upwards of five millions sterling. The facts which have been mentioned in respect to hardness show that a considerable amount of this soap

expenditure is due to the earthy salts in the water; and that the softening of the water, or the removal of the earthy salts before coming in contact with the soap, would occasion a material saving in the quantity of soap used in washing. The difference in the composition of water in its natural state and when softened by the process of Dr. Clark, is shown in Table XIV., Nos. 14, 15, 16, and 17. Plumstead water, derived from the fissures in the chalk formations on the Thames, contains 30·9 grains or degrees of salts or impurity per gallon; by softening, this impurity is reduced to 18·06, or by 12·84°, which consist of earthy salts, to which the water owes much of its hardness. Water from similar strata at Watford, as derived from its natural position, contains 22·4° of impurity, and when softened by Dr. Clark's process, suffers a diminution in impurity and hardness to 8·03°, or by 14·37°, the matter removed being, as in the former case, earthy salts, communicating the quality of hardness to the water. Table XIV. shows the relative composition of Watford and Plumstead waters in their natural and softened states.

But there is another perhaps even more serious objection to hard waters (when this property depends on calcareous matter) which has been urged by the best authorities, that they are prejudicial to the health of persons not in the most robust health, or who have a tendency to the formation of urinary deposits. It has been well ascertained that many persons with a predisposition to certain diseases are only attacked by such complaints when their diet has been of an improper description. "Of hundreds of individuals," says Dr. Prout, "in whom the oxalic acid diathesis prevails, a few "only suffer from calculus;" but well marked instances have occured in which an oxalate of lime nephritic attack has followed the free use of rhubarb, "particularly when the patient has been in the habit at the "same time of drinking *hard* water." Again he says:—"The quality "of the water employed is of the utmost importance. Those whose "assimilating organs form oxalic acid, and who at the same time "drink water containing lime, are exceedingly liable to get an "oxalate of lime calculus. The purest water, therefore, that can be "obtained, even distilled water, should in all instances be preferred." The occurrence of oxalic acid in the system is by no means rare; on the contrary, it is so frequent that it has been viewed by some, although probably erroneously, as by no means of import in the category of disease. "Hard and impure waters," again says Dr. Prout, "possess great influence on urinary diseases and deposits; an old "opinion, of which I am constantly reminded by experience. They "operate in various ways, and produce very different effects on "different diseases and constitutions; but their general influence "in all forms of urinray deposition is, according to my observation, "very unfavourable." It is evident that these observations refer to the influence of hard waters generally, as well as to their special effect; and I believe the experience of all who have devoted attention to the chemical conditions of the system will be found consonant with that of Dr. Prout, who is pre-eminently the father of organic chemistry as applied to medicine.

Waters supplied to Provincial Places affected with Cholera. (Table XVII.)

The waters supplied to provincial localities where cholera occurred, in addition to those places already mentioned, were found to be very impure. The waters of Sandgate are exceedingly hard, and vary in composition, being 40·96° or grains of impurity per gallon, and the least impure being possessed of 31·54° of impurity. The amount of organic matter varied from 5·2° to 3·74°. Three samples of water were examined from Newton Abbott, Bovey Tracey; one was from "the running brook from Narrowcombe under Woodhouse "before joining the mine water." It contained 102·1° of impurity and 12·2° of organic matter. A second specimen, "taken from the "mine, consisting of the engine-delivered water from the 40-fathom "shaft, and the washing water from the shutes and platforms" (mine produces lead, silver, zinc, arsenic, &c.), possessed 63·3° of impurity and 8·9° of organic matter. A third sample, "taken "from the stream at Levaton," had 153·24° of total and 7·84° of organic impurity. No traces of any of the metals enumerated could be detected in any of them. But in the first specimen numerous and large crystals of Glauber's salt were obtained by evaporation; a saline aperient by no means desirable as an ingredient in the food of persons either predisposed or actually under the influence of the premonitory stage of cholera.

Comparison of the Metropolitan Water Supply with the Water of some other Towns.

In the course of this report several important facts have been detailed, which seem to show that the waters supplied for the consumption of the inhabitants are not such as the present condition of medical science warrants the use of. In order that a comparison may be instituted between the London waters and those of various towns and rivers, of which my own observations enable me to furnish data, Table XVI. and Diagram E. are appended. From the facts afforded by these documents, it will be observed that the Scottish towns are in advance of the metropolis in reference to the water supply. Glasgow has long derived its water from the river Clyde, which is possessed of an impurity of 9·57°. The portion of the inhabitants of the city south of the Clyde was, some years ago, not satisfied with using the water of a river which has served as a drain or sewer to an extensive district of country, and succeeded in bringing in a purer water from the adjacent hills. This Gorbals Company's water has an impurity of 7·80°. But even this water, although it is nearly three times purer than the Thames Ditton water after rains, was not sufficiently pure, it was considered, for a large population, and it has now been decided to bring in the water of the romantic Loch Katrine from the borders of the Highlands, with an impurity of only 2° above distilled water. In the diagram E., the inferiority of the London waters is at once caught by the eye, as they commence where the curve rapidly rises. Several of these waters are, no doubt, represented here in their most favourable condition, while others, such as the Chelsea water, appear in their worst aspect, yet all contrast most unfavourably with the earlier portion of the curve. The true

theory of a pure water is to collect rain water as soon after it has fallen on the earth as possible, to store it, and expose it to the atmosphere, so that it may absorb air. This is effected most conveniently by having recourse to the origin of streams in their progress down the hill or mountain side, or, in short, by detaching the water from the most convenient and early source of rivers and streams. In a mountainous region, as in the Highlands of Scotland or in Wales, the drainage of a large elevated district is deposited in lakes or natural reservoirs, which ought to be studied by the engineer as the types of the most perfect possible source of a water supply. The data now given exhibit the advantages obtained by procuring water which has traversed the surface of a rock, or soil destitute of much soluble matter. The water of Loch Katrine, derived from a drainage of surface consisting of insoluble mica slate rocks, is a striking example in point. The river Dee likewise, traversing slaty and granitic soils, reaches Aberdeen after a course of upwards of 90 miles with only 4 degrees of impurity; while the river Tay, after draining an extensive district of slate rocks, approaches the sea at Perth with an impurity rarely exceeding 5·5°. The water brought into the town of Stirling with an impurity of 5·29° is derived from hills of considerable elevation, formed of an indurated greenstone trap. An occasional impurity, which might have been wholly prevented in this instance, has been the contamination by the soluble matter of peat turned up in the formation of an artificial reservoir. This source of taint is, of course, avoided when the drainage of a district is received in natural reservoirs in the form of lakes, as in the mountainous parts of the country, or when considerable expense is incurred by the formation of an artificial bed to the reservoir. The impurity in such cases is principally organic matter, which, when burned, evolves the odour of ignited peat, while the amount of saline matter in solution is comparatively insignificant, but, of course, varies with the geological formation on which the rain water falls. In Table XVI. it will be observed that the rivers Tyne, Tweed, and Seine are closely allied in composition, being nearly twice as pure as the river Thames at Thames Ditton in 1851, and about one-third less impure than the same water in 1854. Even the purest wells at Glasgow and Liverpool, which admittedly contain portions of sewage, are superior to the Thames water destined for the supply of a large portion of the metropolis. Yet these wells are about to be abandoned by the inhabitants of those cities as unfit for human consumption, while the inferior Thames water has been only lately fixed on as a proper source of supply. It is impossible to view this circumstance otherwise than as a very unfortunate one.

Superior Sources of Supply for London.

In consequence of the contamination of the river Thames by organic matter, and the resulting tendency to the production of animalcules which I have found in all weathers in the water, even when the temperature of the atmosphere had remained under the freezing point for some weeks, and the liability to the introduction of foreign matter into the other waters, the discovery of

a pure source of supply seems to be one of the great questions of the day in relation to the health of the metropolis. To assist in forwarding this important object, it seemed most desirable, not only to be able to detect faults, but likewise to be able to afford some mode of obviating the difficulties pointed out by the chemical examination exhibited in this report. Through the attention of S. C. Homersham, Esq., engineer of the Plumstead Waterworks, I have been enabled to make some analyses of the waters derived from the chalk strata, and to examine upon a sufficiently large scale the method of purifying such water for domestic purposes. The water supplied at the present time to the three parishes of Plumstead, Woolwich, and Charlton, by the Plumstead Consumers' Pure Water Company, is derived from fissures in the chalk by means of a vertical shaft and horizontal adit. The water is pumped up from the adit, and is described by the engineer as being most abundant. The temperature in winter, as taken in my presence, was 49·3°, and as it is conveyed from such a distance under the surface, this is no doubt nearly the mean temperature of the water, as well as of the locality. The temperature of the water obtained from a bore terminating at 584 feet below the surface, or 500 feet below Trinity datum, is 53·25° F.; of that from the adit, at about 115 feet from the surface, 49·3°. (Mr. Homersham.) The water, as brought to the surface, is beautifully clear, and nearly destitute of sediment; and if the temperature remains constant at 49·3° throughout the year, or even within a degree or two of this point, it cannot fail to be a cooling and refreshing beverage. But what must be considered of the greatest importance is the fact of its not being subject to contamination by organic matters; and even if these should gain access to the rain water, which is the primary source of this deep aqueous deposit, the extent of percolation through the porous chalk will tend to oxidize the organic matters, and convert them into new inert forms. The total quantity of impurity in the Plumstead chalk water I found to be 30·9 degrees or grains per imperial gallon; of this 2·72° were organic matter. The hardness of this water I found to be 19·63°, which was due to 11·406° carbonate of lime, 1·45° carbonate of magnesia, and 8·864° sulphate of lime. The carbonate of lime can be removed by Dr. Clark's process, and when thus subjected to the purifying influence of lime the hardness becomes only 7·47°, or the water is made about twice as soft as the river Thames is in its natural state. The softening, however, might be carried a little farther, as I still found nearly half a degree of the residual hardness due to carbonate of lime. In Table XIV. the composition of the Plumstead water before and after softening is exhibited in Columns 3 and 4. The softening process of Dr. Clark is carried out at these works in a most practical and efficient manner, so as to do great credit to the proposer of the chemical plan, and to the engineer by whom the work has been contrived and is conducted. The result of the process seems simply to remove chalk from its state of solution and to precipitate it in the form of a crystalline powder, which, when dry, sparkles in the sun, and under the microscope presents the aspect of minute rhomboidal crystals. Although there seems no evidence, from the comparative analyses, that any organic matter is removed by the

softening process from the natural water, at least it is certain that a considerable portion of organic matter remains in the softened water, as has been ascertained by repeated careful trials. Still some circumstances have been noticed, in conducting the process on the large scale, which seem to render it certain that the tendency to vegetation in the softened water is either checked or entirely destroyed. A reservoir, for example, situated at an elevation above the works, when formerly filled with the chalk water as pumped from the well, was covered in its bed with abundance of green aquatic vegetation; but since the introduction of the softened water into the same reservoir few or no symptoms of vegetation are apparent, so that the water is perfectly transparent, and permits the clear bottom to be distinctly visible. This preservative power may be explained by the supposition that the lime and vegetable matter have formed a chemical compound, or that sporules seem less liable to vegetate in an alkaline state derived from causticity than in an acid fluid—an observation which was frequently made, and is noticed under the report of the examination of the atmospheres during the prevalence of the epidemic. The Plumstead water seems well adapted for domestic use. The only drawback is, that the hardness still remains at 7½°, even after the application of the softening process; and this is incapable of further reduction, in consequence of the lime salt (the cause of the hardness) being in the state of a soluble sulphate of lime, which remains unaffected by the addition of milk of lime to the water. There seems ground of belief, however, that the waters, stored in the chalk formations, vary in their relative composition somewhat in different localities. Thus the Gravesend water appears to be capable of undergoing a greater amount of softening than that brought to the surface at Plumstead; and there can be little doubt that a selection might be made of softer descriptions of water, and better adapted for the application of the softening process, should proper attention be directed to the waters deposited in the chalk strata, which have hitherto received a less share of public interest than their importance and value seem to demand. The geological observations which have been made on the chalk strata appear to indicate that unlimited supplies of water may be obtained from these porous deposits, which at present pass into the sea or the river Thames, and require only to be intercepted, as they have been at Plumstead, to afford this important beverage, in a comparatively pure form, to any amount of population. I am indebted to Mr. Homersham, likewise, for the opportunity of being able to make an analysis of hard and softened water of a still purer description from the chalk of Watford, a source from which it has been proposed to convey the purified water to town in pipes. A company was formed for the purpose; but, as in many other attempts to improve the health of the metropolis, private influence seems to have failed. The Watford water (Table XIV. 1 & 2) was found to have a total impurity of 22°, and a hardness of 17·45°. The organic matter amounted to 1·4°. When softened by liming, the total impurity is found to be 8·030°, and the hardness is reduced to 2·75° or it is diminished by 14·7°. Hence we see, that by this purifying process we are able to obtain a water which, originally of the same degree of im-

purity as Thames water, becomes in some measure comparable with the water supplied to Glasgow, &c. (Table XVI., 9. Diagram E.)

These and other sources of supply in the environs of the metropolis are well deserving of attention, from the commercial companies to whom London is at present indebted for its water supply.

I have not succeeded in detecting lead in any of the specimens of water subjected to examination, although some of the waters possessed an action on lead when experiments were made on a small scale in the laboratory. This affords evidence that, so far as the metropolitan waters are concerned, the corrosion of lead is not a practical objection to the employment of pipes and cisterns of that metal, although no doubt it would be preferable to dispense with its use if possible. Although sulphuretted hydrogen has not been described in this report as entering into the composition of Thames water, I obtained abundant evidence of its presence in the river, during the construction of the Thames Tunnel, when water from the river saturated with that gas made its way into the tunnel, and proved injurious to the workmen by escaping from its solution and contaminating the atmosphere.

Summary.

The facts communicated in these reports seem to demonstrate:

1. That in the waters examined, which were taken from houses where deaths had occurred from cholera, with some exceptions impurity was their characteristic feature; and that it is difficult to disconnect this fact from the propagation of the epidemic.

2. That some of the metropolitan waters were particularly impure; and that even water derived from the river Thames at the point from which the water of that river is soon to be entirely taken for the supply of London, contains matters which show that it is subject to contamination by most objectionable impurities.

3. That the water distributed to the metropolis, when compared with that of many other towns, stands low in the scale of purity and wholesomeness.

4. That the shallow wells of London and of other localities in the immediate neighbourhood of human habitations, being surrounded by matter soaking in from cesspools and surface filth, are liable to be impregnated with surface impurities, and that their closure would be a benefit to the health of the community.

5. That the waters derivable from the environs of London which are not liable to be contaminated with human excretions deserve to be thoroughly investigated, not only in their chemical relations, but likewise as to the possibility of their existing in sufficient abundance to satisfy the demands of a large population.

6. That from the remarkably variable chemical character of the metropolitan water supply, the frequent periodical examination of the waters as distributed to the houses in London might have a beneficial influence in securing a more agreeable and wholesome form of fluid for consumption.

Robert Dundas Thomson, M.D.

St. Thomas's Hospital,
January 1855.

TABLES exhibiting the CHEMICAL COMPOSITION of METROPOLITAN WATERS, September to December 1854.

TABLE I.

TABLE exhibiting the DEGREES of IMPURITY of the RIVER THAMES between VAUXHALL and GREENWICH, each Degree being equal to One Grain per Gallon.

—	Vauxhall.	Hungerford.	London Bridge.	Greenwich.
I. *High Water*, 8*th December* 1854.				
Mechanical impurity	60°·50	64°·64	63°·44	° —
Organic „ -	5·28	5·80	4·72	—
Inorganic „ -	36·64	45·24	45·08	—
Total Impurity -	102·42	115·68	113·24	—
II. *Low Water*, 2*d September* 1854.				
Mechanical Impurity	° 10·26	° 16·80	° 3·52	° 3·70
Organic „ -	4·34	8·40	7·36	19·44
Inorganic „ -	12·54	23·64	21·20	72·54
Total Impurity -	27·14	48·84	32·08	95·68

THAMES DEPOSIT alongside the DREADNOUGHT.

	Dec. 1850.	March 1850.
Water - - - - -	9·04	9·27
Organic Matter - - -	21·28	15·45
Silica and Clay - - -	69·68	75·28
	100·	100·

TABLE II.

TABLE exhibiting the DEGREES of IMPURITY of LAMBETH WATER COMPANY, or RESIDUE, per Gallon, in Grains.

—	Date when taken.	Cholera Cases.	HOUSE.	Degrees of Total Impurity, or Total Residue, per Gallon, in Grains.	Organic Matter.
	1854.		*Lambeth District.*	°	
*1	Sept. 5	1	66, Wootten Street - -	13·72	
2	"	1	111, Cornwall Road - -	13·03	
3	"	1	107, Cornwall Road - -	13·	
4	"	1	17, Commercial Road -	13·07	
5	"	0	126, Waterloo Road - -	14·16	
			Mean - -	13·39	
			St. Peter's, Walworth.		°
6	Sept. 16	1	22, Carter Street - -	12·78	1·44
7	"	2	4, Little King Street, Kent Road - - - -	13·78	1·46
8	"	2	7, Monmouth Place - -	12·38	1·03
9	"	3	1, Bedford Court - -	12·12	1·74
10	"	2	21, Bolingbroke Row -	15·74	1·46
			Mean - -	13·36	1·43
11	Nov. 10		126, Waterloo Road - -	17·49	1·36
12	"		Ditto ditto - -	17·40	1·40
13			Mean - -	17·44	1·38
	Sept. 8		Thames Ditton - -	15·76	

* Water in cisterns is found to deposit carbonate of lime.

TABLE III.

TABLE exhibiting the DEGREES of IMPURITY in GRAND JUNCTION WATER, each Degree equal to One Grain per Gallon.

—	Date when taken.	Cholera.	HOUSE.	Degree of Total Impurity.	Organic Matter.
	1854.			°	°
1	Sept. 9	•3	3, South Row, Soho - -	13·04	3·56
2	"	3	5, South Row, Soho -	15·34	4·46
3	"	2	14, Cambridge Street, Soho	16·10	3·82
4	"	4	13, Marshall Street, Soho -	13·36	3·04
5	"	3	39, Broad Street, Soho -	14·46	4·00
			Mean - -	14·46	3·78
6	Nov. 10	- -	5, South Row, Soho - -	17·98	1·88
7	"	- -	Ditto ditto - -	17·92	1·92
			Mean - -	17·95	1·90

TABLE III*.

TABLE exhibiting the DEGREES of IMPURITY in WEST MIDDLESEX WATER.

—	Date when taken.	Cholera.	HOUSE.	Degrees of Total Impurity.	Organic Matter.
	1854.			°	°
1	Sept.	- -	77, Upper Berkeley Street	19·04	1·78
2	Nov. 16	- -	St. John's Wood - -	18·97	2·08
			Mean - -	19·00	1·93

TABLE IV.

Table exhibiting Degrees of Impurity in Southwark and Vauxhall Water, each Degree equal to One Grain per Gallon.

—	Date when taken.	Cholera. Cases.	Deaths.	House.	Degrees of Total Impurity.	Organic Matter.
	1854.			*Lambeth District.*	°	°
1	Sept. 5	-	2	131, Waterloo Road - -	39·64	5·51
2	„	-	1	154, Waterloo Road - -	40·83	-
3	„	-	2	29, Wootton Street - -	39·25	3·65
4	„	-	1	15, Eaton Street - -	39·69	4·78
5	„	-	1	41, Brad Street - -	34·18	3·57
				Mean - -	38·72	4·38
				St. Peter's, Walworth.		
6	Sept. 16	-	2	10, Berkeley Terrace -	46·76	4·26
7	„	-	2	25, Bolingbroke Row -	50·62	4·38
				Mean - -	48·69	4·32
				St. James's, Bermondsey.		
8	„	7	2	Flora Cottage, Blue Anchor Road - - -	34·72	3·72
9	„	-	2	Cottage Row - - -	45·24	3·32
10	„	-	2	9, Prospect Row - -	72·66	4·80
				Mean - -	50·87	3·64
				St. Thomas's Hospital.		
11	Aug. 31	-	-	Laboratory - - -	56·04	4·50
12	Nov. 3	-	-	Cab Stand - - -	41·78	3·64
13	„ 16	-	-	Laboratory - - -	41·80	4·19
				Mean - -	41·79	3·91
	1855.*					
14	Mar. 15	-	-	Laboratory - - -	22·50	2·82
15	„	-	-	Cab Stand - - -	23·80	4·00
16	April 15	-	-	Ditto - - -	23·40	2·16
				Mean - -	23·23	2·99
17	May 7	-	-	Laboratory - - -	32·20	1·86
18	June 7	-	-	Cab Stand - - -	41.88	4.68
				Clapham.		
18	Sept.	-	-	Main Pipe - - - -	54·44	6·26
19	„ 29	-	-	Wandsworth Road, 12, Neptune Street -	68·92	5·20

* These five cases have been added since the report was drawn up.

TABLE V.

Table exhibiting the Degrees of Impurity in Chelsea Water, each Degree equal to One Grain per Gallon.

—	Date when taken.	Cholera. Additional Cases.	Cholera. Deaths.	House.	Total Impurity or Total Residue, in Degrees or Grains.	Organic Matter.
	1854.				°	°
1	Sept. 27	2	2	53, Queen's Road West	60·34	4·96
2	" "	6	2	27, Lawrence Street -	64·30	5·90
3	" "	4	1	3, Heatley's Buildings, Manor Street -	50·40	5·30
4	" "		2	5, Lawrence Street -	65·66	5·50
				Mean -	60·17	5·41
5	Dec. 8	-	-	3, Heatley's Buildings, Manor Street -	36·96	

TABLE VI.

Table exhibiting the Degrees of Impurity in New River Water Company, or Residue per Gallon in Grains.

—	Date when taken.	Cholera. Additional Cases.	Cholera. Deaths.	House.	Degrees of Total Impurity, or Total Residue, in Grains per Gallon.	Organic Matter.
	1854.			*Soho District.*	°	°
1	Sept. 9	3		3, Broad Street - -	33·84	
2	" "	3	2	10, Portland Mews, Portland Street -	27·04	
3	" "	5	2	5, Berwick Street -	30·10	2·46
4	" "	8	8	9, Hopkins Street -	33·26	2·
5	" "	3	2	11, Hopkins Street -	34·94	2·02
6	" "	6		23, Peter Street -	22·14	1·6
7	" "	6		9, Broad Street - -	19·18	
				Mean -	28·64	2·02
8	Nov. 10			9, Hopkins Street -	35·05	1·98
				New River Head.		
1	Oct. 7			Sadler's Wells Theatre	16·32	1·27
	" "			" " "	15·75	1·76
2	Nov. 10			" " "	20·78	2·33
				Mean -	17·62	1·78
3	Oct. 4			Bayley's Yard, Allen Street, Clerkenwell -	17·22	1·46

TABLE VII.

TABLE exhibiting the DEGREES of IMPURITY in EAST LONDON WATER COMPANY, Residue per Gallon in Grains.

—	Date when taken.	Cholera.	House.	Total Impurity or Total Residue, in Degrees or Grains.	Organic Matter.
	1854.			°	°
1	Oct. 7	-	Canal, Lea Bridge -	18·62	
2	,, ,,	-	,, ,,	19·00	1·62
3	,, ,,	-	4, Allen's Cottages, Park Place, Bow - -	17·74	1·60
4	,, ,,	-	,, ,, ,,	17·02	
5	,, ,,	-	25, Willis Street, Bow -	18·44	2·20
6	,, ,,	-	,, ,, ,,	18·98	2·48
			Mean - -	18·30	1·97
	1855.				
7	Jan.	-	Brunswick St., Blackwall	19·60	1·60

TABLE VIII.

TABLE exhibiting the DEGREES of IMPURITY in KENT WATER.

—	Date when taken.	House.	Impurity; Total Residue in Degrees or Grains.	Organic Matter.
	1854.		°	°
1	Sept. 30	From Tap at Works - - -	21·10	2·80
2	,, ,,	From Filter at Works - -	17·16	1·72
3	,, ,,	97, New Street, Deptford - -	15·02	1·48
		Mean - -	17·76	2·00

TABLE VIII*.

TABLE exhibiting the DEGREES of IMPURITY in HAMPSTEAD WATER.

—	Date when taken.	House.	Impurity; Total Residue in Degrees or Grains.	Organic Matter.
	1854.		°	°
1	Sept.	—	24·22	3·88

TABLE IX.

TABLE exhibiting the COMPOSITION of THAMES WATERS in Grains per Gallon as found by Analysis.

——	I. Lambeth Company, supplied at Thames Ditton.	II. Grand Junction Company, supplied at Brentford.	III. West Middlesex Company, supplied at Barnes.	IV. Chelsea Company, supplied at Vauxhall.	V. Southwark and Vauxhall Company.
Organic Matter - -	1·390	1·920	2·080	5·410	3·560
Silica - - - - -	·350	·090	·520	1·511	·240
Sesquioxide of Iron, Alumina, and Phosphates - - -	·215	·730	·460	·639	·460
Insoluble Lime - -	5·680	4·967	5·555	5·348	5·992
Soluble Lime - -	·944	·975	·868	2·649	2·374
Insoluble Magnesia -	·281	·343	·342	·209	·238
Soluble Magnesia - -	·260	·228	·157	1·283	·886
Sodium - - -	·379	·372	·643	11·708·	5·967
Potassium - - -	·328	·249	·259	1·304	1·086
Chlorine - - -	1·020	·980	1·160	19·554	12·160
Sulphuric Acid - -	1·599	1·647	1·504	6·043	2·980
Carbonic Acid - -	9·550	8·560	9·106	8·862	9·941
Nitric Acid - - -	—	—	—	—	·050
Ammonia - - -	·023	—	—	—	·297

1. *Lambeth Company.* Sample taken from cistern, 126, Waterloo Road, 10th November 1854.

2. *Grand Junction Company.* Sample from cistern, 5, South Row, Golden Square, 10th November 1854.

3. *West Middlesex Company.* Cistern, 11, Marlborough Hill, St. John's Wood, 16th November 1854.

4. *Chelsea Company.* Mixed Salts from 53, Queen's Road, 27, and 5, Lawrence Street, 3, Heatley's Buildings, from cisterns.

5. *Southwark and Vauxhall.* From the Stand pipe opposite St. Thomas's Hospital, 3d November 1854.

The terms insoluble and soluble refer to the chemical characters of the residue by evaporation.

TABLE IX.*

TABLE exhibiting the COMPOSITION of THAMES WATERS, in Grains per Gallon, calculated from the preceding TABLE.

—	I. Lambeth Company.	II. Grand Junction Company.	III. West Middlesex Company	IV. Chelsea Company.	V. Southwark and Vauxhall Company.
Organic Matter - -	1·390	1·920	2·080	5·410	3·560
Silica - - -	·350	·090	·520	1·511	·240
Sesquioxide of Iron, Alumina, and Phosphates. - - -	·215	·730	·460	·639	·460
Carbonate of Lime -	10·144	8·870	9·919	9·550	10·700
Sulphate of Lime - -	2·149	2·368	2·109	6·432	3·179
Chloride of Calcium -	—	—	—	—	2·108
Nitrate of Lime - -	trace	trace	trace	trace	·076
Carbonate of Magnesia	0·592	0·720	·720	·438	0·500
Sulphate of Magnesia -	—	—	—	1·390	—
Chloride of Magnesium	·617	·542	·360	1·947	2·101
Sulphate of Potash -	·730	·553	·577	2·903	2·413
Chloride of Sodium -	·966	·947	1·637	29·797	16·001
Total - - -	17·153	16·740	18·443	60·017	40·564
Residue by Evaporation	17·440	16·920	18·970	60·170	41·780
Carbonate of Ammonia	·064	—	—	—	·840

TABLE X.

TABLE exhibiting the COMPOSITION of the NEW RIVER, EAST LONDON, and KENT COMPANIES' WATERS, as found by Analysis, in Grains per Gallon.

——	VI. New River, New River Head.	VII. New River Company, supplied to Soho.	VIII. East London.	IX. Kent Company.
Organic Matter - -	2·330	1·980	1·940	1·480
Silica - - - -	·180	·780	·320	·420
Sesquioxide of Iron, Alumina, and Phosphates - - -	·400	·210	·520	·130
Insoluble Lime - -	6·712	3·967	6·718	5·342
Soluble Lime - -	·918	·627	·449	1·254
Insoluble Magnesia -	·407	·565	·354	·100
Soluble Magnesia -	trace	trace	·100	·400
Sodium - -	0·925	9·951	·442	·343
Potassium - - -	·320	·569	·307	·518
Chlorine - - -	1·430	4·740	·860	1·240
Sulphuric Acid - -	1·393	6·015	·841	2·344
Carbonic Acid - -	11·442	11·554	11·336	8·616
Nitric Acid - - -	trace	trace	trace	trace
Ammonia - - -	trace	trace	trace	trace

6. The analysis here given is of a mixed salt from the open conduit at Sadler's Wells, and of water from the reservoir.

7. The water was taken from the cistern at 9, Hopkins Street.

8. The East London salts were obtained from waters mixed from cholera houses enumerated in Table VII., and from the New Canal at Lea Bridge.

9. Kent Company. This sample was a mixed one, as mentioned in Table VIII.

TABLE X.*

TABLE exhibiting the COMPOSITION of the NEW RIVER, EAST LONDON, and KENT COMPANIES' WATERS, as calculated from the preceding Tables, in Grains per Gallon.

—	VI. New River Company, New River Head.	VII. New River Company, supplied to Soho.	VIII. East London Company.	IX. Kent Company.
Organic Matter - -	2·330	1·980	1·940	1·480
Silica - - - - -	·180	·780	·320	·420
Sesquioxide of Iron, Alumina, and Phosphates - - -	·400	·210	·520	·130
Carbonate of Lime -	11·985	7·085	11·997	9·540
Sulphate of Lime - -	1·812	1·523	·897	3·085
Chloride of Calcium -	—	—	—	—
Nitrate of Lime - -	trace	trace	trace	trace
Carbonate of Magnesia -	·855	1·185	·743	·210
Carbonate of Soda -	trace	4·909	—	—
Sulphate of Magnesia -	trace	trace	trace	trace
Chloride of Magnesium	trace	—	·237	·949
Sulphate of Potash -	·712	1·266	·682	1·153
Sulphate of Soda - -	—	8·051	—	—
Chloride of Sodium -	2·355	7·807	1·125	·874
Total - - -	20·629	34·796	18·461	17·841
Residue by Evaporation	20·780	35·050	18·300	17·760

TABLE XI.

TABLE exhibiting the DEGREES of HARDNESS of METROPOLITAN WATERS.

Each Degree equal to One Grain of Carbonate of Lime per Gallon.

Lambeth Company - - -	13°·2
New River Company (New River Head) -	14·0
Grand Junction Company - - -	12·6
Kent Company - - -	12·2
East London Company - - -	14·2
West Middlesex Company - -	12·8
New River Company (supplied to Soho) -	9·6
Southwark and Vauxhall Company - -	18·2
Chelsea Company - - - -	18·4

TABLE X.

TABLE exhibiting the COMPOSITION of the NEW RIVER, EAST LONDON, and KENT COMPANIES' WATERS, as found by Analysis, in Grains per Gallon.

—	VI. New River, New River Head.	VII. New River Company, supplied to Soho.	VIII. East London.	IX. Kent Company.
Organic Matter - -	2·330	1·980	1·940	1·480
Silica - - - -	·180	·780	·320	·420
Sesquioxide of Iron, Alumina, and Phosphates - - -	·400	·210	·520	·130
Insoluble Lime - -	6·712	3·967	6·718	5·342
Soluble Lime - -	·918	·627	·449	1·254
Insoluble Magnesia -	·407	·565	·354	·100
Soluble Magnesia -	trace	trace	·100	·400
Sodium - -	0·925	9·951	·442	·343
Potassium - - -	·320	·569	·307	·518
Chlorine - - -	1·430	4·740	·860	1·240
Sulphuric Acid - -	1·393	6·015	·841	2·344
Carbonic Acid - -	11·442	11·554	11·336	8·616
Nitric Acid - - -	trace	trace	trace	trace
Ammonia - - -	trace	trace	trace	trace

6. The analysis here given is of a mixed salt from the open conduit at Sadler's Wells, and of water from the reservoir.

7. The water was taken from the cistern at 9, Hopkins Street.

8. The East London salts were obtained from waters mixed from cholera houses enumerated in Table VII., and from the New Canal at Lea Bridge.

9. Kent Company. This sample was a mixed one, as mentioned in Table VIII.

TABLE X.*

TABLE exhibiting the COMPOSITION of the NEW RIVER, EAST LONDON, and KENT COMPANIES' WATERS, as calculated from the preceding Tables, in Grains per Gallon.

—	VI. New River Company, New River Head.	VII. New River Company, supplied to Soho.	VIII. East London Company.	IX. Kent Company.
Organic Matter	2·330	1·980	1·940	1·480
Silica	·180	·780	·320	·420
Sesquioxide of Iron, Alumina, and Phosphates	·400	·210	·520	·130
Carbonate of Lime	11·985	7·085	11·997	9·540
Sulphate of Lime	1·812	1·523	·897	3·085
Chloride of Calcium	—	—	—	—
Nitrate of Lime	trace	trace	trace	trace
Carbonate of Magnesia	·855	1·185	·743	·210
Carbonate of Soda	trace	4·909	—	—
Sulphate of Magnesia	trace	trace	trace	trace
Chloride of Magnesium	trace	—	·237	·949
Sulphate of Potash	·712	1·266	·682	1·153
Sulphate of Soda	—	8·051	—	—
Chloride of Sodium	2·355	7·807	1·125	·874
Total	20·629	34·796	18·461	17·841
Residue by Evaporation	20·780	35·050	18·300	17·760

TABLE XI.

TABLE exhibiting the DEGREES of HARDNESS of METROPOLITAN WATERS.

Each Degree equal to One Grain of Carbonate of Lime per Gallon.

Lambeth Company	13°·2
New River Company (New River Head)	14·0
Grand Junction Company	12·6
Kent Company	12·2
East London Company	14·2
West Middlesex Company	12·8
New River Company (supplied to Soho)	9·6
Southwark and Vauxhall Company	18·2
Chelsea Company	18·4

Table XII.

Table exhibiting the Degrees or Grains per Gallon of Impurity of London Wells.

Distilled water, 0°.

	Date.	Situation.	Total Impurity in Degrees or total Residue in Grains.	Organic Matter and Nitric Acid.	Degrees of Mechanical Impurity.
1.	Jan. 18, 1854	Aldgate pump -	49°12	13°94	
2.	Feb. 1854 -	Ditto - - -	44°64	6°30	
3.	Mar. 1855 -	St. Thomas's pump	89°70	10°40	
4.	May 15, 1854	Camberwell -	62°67	10°69	
5.	Nov. 25, 1854	Ditto - - -	48°72	7°26	
6.	July 20, 1854	Blackheath - -	28°00		
7.	Sept. 1854 -	Broad-street, Soho -	92°06	7°80	
8.	„ „ -	Buckingham Palace well - - -	59°00	8°08	
9.	„ „ -	Charing-cross Artesian well, supplied at Buckingham Palace - -	56°04	2°12	
10.	- - -	Putney, Cock's-buildings - -	180°40	16°00	
11.	- - -	„ Price's-folly -	101°30	14°00	
12.	- - -	„ Stratford-grove	67°20	14°80	

Provincial Wells.

12*	Jan. 1854 -	Newcastle Military well - - -	100°56	15°052	
13.	Sept. 1854 -	Brasted, Kent -	54°10	8°300	1°5
14.	Oct. 21, 1854	Plumstead, hard (in chalk) - -	30°90	2°720	
15.	„ „ -	„ softened -	18°06	2°800	
16.	Nov. 1854 -	Watford, hard (in chalk) - -	22°40	1°400	
17.	„ „ -	„ softened -	8°03	1°420	
18.	- - -	Nottingham - -	42°24	3°200	101°87
19.	- - -	Hadley, Mill-corner	83°20	27°600	37°81
20.	- - -	Newton, Wisbeach, „ No. 1 -	481°76	49°600	3°20
21.	- - -	„ No. 2 -	348°80	21°600	9°33

TABLE XIII.

	Well at Camberwell. May 15, 1854.	Well at Camberwell. Nov. 25, 1854.	Well in Broad-street, Soho, Sep. 9. 1854.
Organic matter, nitric acid, ammonia - - -	12·900	7·260	7·800
Silica - - - - - -	- - -	·320	·539
Sesqui-oxide of iron, alumina, and phosphate of lime -	·250	·180	·944
Carbonate of lime - -	3·710	7·080	13·926
Sulphate of lime - - -	25·899	12·758	11·874
Chloride of calcium - -	- - -	3·424	14·928
Carbonate of magnesia -	·097	1·380	1·618
Chloride of magnesium -	- - -	4·749	7·550
Sulphate of potash - -	6·104	4·202	14·883
Carbonate of soda - -	- - -	1·113	5·233
Chloride of sodium - -	13·880	6·134	12 070
Total - -	62·840	48·600	91·555
Residue by evaporation -	62·690	48·720	92·060

TABLE XIV.

TABLE exhibiting the COMPOSITION of the WATFORD and PLUMSTEAD CHALK WATERS in their natural State, and when softened by Dr. Clark's Process.

	1. Watford. *Hard Water.*	2. Watford. *Softened Water.*	3. Plumstead. *Hard Water.*	4. Plumstead. *Softened Water.*
Organic matter - -	1·400	1·420	2·720	2·800
Silica - - - - - -	·480	·680	·720	·720
Alumina, sesqui-oxide of iron, and phosphate of lime - -	·240	·120	·340	·280
Carbonate of lime - - -	15·280	·520	11·406	·400
Sulphate of lime - - -	·377	·590	8·864	8·976
Nitrate of lime - - -	1·599	1·580	—	—
Carbonate of magnesia - -	·870	·390	1·450	·400
Sulphate of potash - - -	·569	·569	·284	·284
Sulphate of soda - - -	- -	- -	1·235	1·445
Chloride of sodium - - -	1·153	1·518	3·558	3·064
Total per gallon - - -	21·968	7·327	30·577	18·369
Residue by evaporation - -	22·400	8·030	30·900	18·280
Hardness - - - -	17·45	2·74	19·63	7·47

Table XV.

Table exhibiting the Impurity of Provincial Well Waters expressed in Degrees or Grains per Gallon.

			Total Residue in Degrees or Grains.
		Glasgow Wells.	
1.	June 1847 -	Stirling-square - - - - -	99°5
2.	Feb. 1848 -	St. David's - - - - - -	83·3
3.	" " -	Bridge-gate - - - - - -	84·4
4.	Jan. 1848 -	Orr-street - - - - - - -	79·8
5.	Feb. 1848 -	Cheapside - - - - - -	71·9
6.	" " -	Cannon-street - - - - - -	58·84
7.	March 1848 -	Ditto - - - - - - - -	66·20
8.	Feb. 1848 -	Wilson-street West - - - - -	64·20
9.	June 1847 -	George-street - - - - - -	57·90
10.	Feb. 1848 -	Cochrane-street - - - - - -	51·80
11.	June 1847 -	Union-street - - - - - -	52·90
12.	" " -	St. Vincent-street - - - - -	51·60
13.	Feb. 1848 -	Norfolk-street - - - - - -	50·64
14.	March 1848 -	Ditto - - - - - - -	43·24
15.	June 1847 -	Glassford-street - - - - -	40·00
16.	" " -	Infirmary Well - - - - - -	25·60
17.	" " -	Lady Well - - - - - -	17·73
18.	" " -	Arn's Well (Green) - - - - -	14·9
		Liverpool Wells.	
1.	Jan. 19, 1850	Vauxhall-road (1050 yds. from river)*	417·02
2.	" " -	Batchelor-street (760 do) - - -	299·45
3.	" " -	Crone's Sugar Refinery - - -	228·48
4.	" " -	Barton's Tan-yard - - - - -	237·90
5.	" " -	Smithfield (800 yards from river) -	226·25
6.	" " -	Steele's Soapwork - - - - -	113·68
7.	" " -	Gregson's Sawmills - - - - -	107·91
8.	Jan. 21, 1850	Holmes's, Benson-street - - -	51·01
9.	" " -	Bevington Bush - - - - -	48·63
10.	Feb. 14, 1850	Ditto - - - - - - -	55·90
11.	Jan. 21, 1850	Copperas-hill - - - - - -	31·60
12.	- - -	Hotham-street - - - - -	29·60
13.	- - -	Windsor Station - - - - - -	25·50
14.	- - -	The Park - - - - - -	22·95
15.	- - -	Edgehill - - - - - - - -	22·29
16.	- - -	Soho - - - - - - - -	22·30
17.	- - -	Bootle - - - - - - -	19·40
18.	- - -	Ditto - - - - - - - -	18·90
19.	- - -	Windsor Well - - - - - -	17·96
20.	- - -	Water-street - - - - - - -	17·80
21.	- - -	Green-lane - - - - - -	13·80

* The distances supplied by James Newlands, Esq., C. E.

Table XVI.

Table exhibiting the Degrees of Impurity in Waters used for the Supply of Towns in England, Scotland, &c.; each Degree being equal to One Grain per Gallon.

	Distilled water	0°.
1.	Loch Katrine	2·
2.	Dee, Aberdeen	4·
3.	Tay, Perth	5·5
4.	Stirling	5·29
5.	Dumfries	6·96
6.	Paisley	7·59
7.	Gorbals	7·80
8.	Leven	8·60
9.	Clyde	9·57
10.	Tyne, Newcastle	11·16
11.	Tweed, Coldstream	11·66
12.	Seine, Paris	11·78
13.	Liverpool Well (purest)	13·80
14.	Glasgow Well (ditto)	15·00
15.	Kilmarnock	15·22
16.	Thames Ditton (1854)	15·52
17.	„ „ (1851)	21·33
18.	Swindon	17·51
19.	Glasgow Well (most impure)	96·00
20.	Liverpool Well (ditto)	417·02

Table XVII.

Table of the Impurities in Waters supplied to some Provincial Places in Grains or Degrees per Gallon.

——		Total Degrees of Impurity, or Grains per Gallon.	Degrees of Organic Impurity.
1. Bovey Tracy, Newton Abbott	Brook	102·1	12·20
2. Ditto	Mine	63·3	8·90
3. Ditto	Stream	153·24	7·84
4. Sandgate—Bellevue House		40·96	5·20
5. Ditto Reservoir		31·54	4·00
6. Ditto Mr. George's house		31·64	3·74

No. VIII.

Report on the Microscopical Examination of different Waters (principally those used in the Metropolis) during the Cholera-Epidemic of 1845. By Dr. Hassall.

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INTRODUCTORY REMARKS.

Before proceeding to enumerate the different kinds of living organic productions, discovered by means of the microscope, in the various samples of water subjected to examination, it will be well to inquire the meaning and signification which attach to their presence in certain waters. We shall then be in a position to appreciate the nature and purport of the results arising out of the several examinations.

Water consists of hydrogen and oxygen, chemically combined in a definite proportion; of these two elements water of all kinds consists, and whatever matters are contained in it besides these have nothing to do with its composition, and are really extraneous.

But water, like all other substances, is endowed with certain physical properties; and amongst them is the power of absorbing any gases with which it may happen to be in contact. Now, as nearly all water is more or less freely exposed to the atmosphere, the gases of which the latter is formed, viz. oxygen and nitrogen, are nearly always present in water, in greater or less proportions, besides carbonic acid gas also derived from the air through which it is diffused.

Chemically pure water then consists of oxygen and hydrogen in combination, holding in solution, when exposed to the air, the elements of which this is composed. Should the atmosphere itself contain other gases, a proportion of these will likewise be taken up by the water, and hence results one kind of impurity, viz. that arising from the imbibition of one or more hurtful gases.

The greatest and most important contamination to which water is prone is that by organic matter. This may exist in water in several forms and states; it may be either dead or living, vegetable or animal, solid or fluid, and it may be present in water in all these different forms and states.

Now organic matter has a chemical constitution wholly distinct from that of water, its great distinguishing characteristic being that it contains nitrogen, which is greater in amount in animal than in vegetable productions. No constituents enter into the composition of chemically pure water, out of which living organic productions can be developed, or if developed, sustained. The presence of these affords evidences of contamination with nitrogenous matter, and they are to be regarded as a sign of impurity. Since the majority of organic productions are nourished by imbibition, their existence in water implies the presence of organic matter in a fluid state, capable of being absorbed into their systems, and of sustaining them. Some of the higher forms of infusoria have, however, stomachs, and feed upon solid organic matter, either living or dead.

If these premises are correct, as they unquestionably are, we repeat that the presence of organic matter in water, whether in the

state or solid, and dead or living, animal or vegetable, and especially living animalcules in water, are to be regarded as undoubted proofs of contamination or impurity.

When vegetable productions abound in water, they indicate a positive degree of impurity; but when animalculæ abound, a higher degree of impurity is indicated, because these contain a much larger proportion of nitrogenized matter.

But the absence of organic productions, including infusoria, does not afford a certain proof of the purity of any water, because the concurrence of other conditions is necessary for the development of organic life, viz. more or less air, light, and warmth. For the development of some productions these agents must all have free access to the water; for others a limited supply of them only is necessary, while the existence of others is compatible with the admission of but little air or light, and especially with a low temperature; thus many organic productions, infusoria amongst the number, survive through the most rigorous winters.

When the above agents are entirely, or almost entirely, excluded, but little development takes place, even although the water contain nitrogen or nitrogenized matter of any kind, but a distinct series of changes occur, the nitrogen of the nitrogenized matter becomes oxydized and nitric acid is generated, which uniting with bases forms nitrates. These changes are constantly going on in wells contaminated by the contents of cesspools.

It is of extreme importance that correct notions should prevail respecting the real signification of the presence of animalculæ and other minute forms of organic life in water, for much error exists on this subject in the minds of the public, and even on the part of some few men professing acquaintance with the laws of science.

Many of the public believe that everything we eat and drink teems with life, and that even our bodies abound with minute living and parasitical productions. This is a vulgar error, and the notion is as disgusting as it is erroneous.

In the entire human body, in a state of health and cleanliness, not a single organic production or animalcule of any description, or of the most minute size discoverable with the microscope, excepting probably, under some circumstances, vibriones in the intestinal canal, is present, either outwardly on the surface or inwardly in the cavities, or in the several secretions of the body.

When the body becomes diseased or greatly disordered, or cleanliness is not observed, then, indeed, some few parasitical productions may take up their residence in it, but even in this case the proper secretions and fluids of the body, as the bile, blood, &c., are rarely, if ever, thus infested. The productions then found are, on the skin, chiefly acari, and in the intestinal canal a few species of annelidæ or worms.

The belief that the articles we eat and drink abound in infusorial life is equally unfounded. It is not true of even a single article of consumption, which is partaken of while in a sound and wholesome

state. The only substance with which we are acquainted which commonly contains living organic productions, as the larvæ of a species of fly, acari, and fungi, is cheese, and these only become developed in it after decomposition has commenced, while sound cheese is entirely free from the contaminations. Another reason why cheese is so prone to be thus attacked is explained by its highly nitrogenous character, which predisposes it to decomposition. Let the notion, then, that the articles we eat and drink, and even our very bodies, teem with invisible and parasitical forms of life be dismissed from the mind, for such a notion is opposed to every true principle of science, and is plainly contradicted by direct observation.

It was essential that the above observations should be made preliminarily to stating the results of the Microscopical Examination of the different waters, in order, as we have before remarked, that the purport of those results should be more clearly understood.

The following was the method pursued in the collection and examination of the different samples:—

They were collected, for the most part, in Winchester quart bottles, which hold half an imperial gallon, care being taken that they should be scrupulously clean. Each specimen was set aside at rest for some hours previous to examination; it was then first examined while undisturbed, and notes were taken of the different objects observed under the microscope. All the contents of the bottle were next decanted, except about 10 or 12 oz., so as not to disturb any sediment which might have fallen. These were poured into a conical glass lightly covered, so as to prevent dust or any other matter floating in the air from getting in, and set aside for a further period of about six hours. The water contained in the tumblers at the expiration of that time was decanted, reserving only the last few drops, which were subjected to microscopical examination. When the quantity of sediment was exceedingly minute, so little indeed as in the case of the purer waters almost to escape the eye altogether, the remaining drachm or so of the water from the tumblers was transferred into a very small conical glass, and allowed to rest an hour or so; the water in this in its turn being decanted, and in this way any sediment which was present was collected.

In procuring waters for microscopical examination, they should, where practicable, for the sake of comparison, be obtained in bottles similar to those above referred to, viz., Winchester quart bottles.

Of the waters examined, some were taken from *the cisterns of houses* in which one or more deaths from cholera had occurred, these being procured in many cases from localities in which the disease was at its height, and from districts the most severely visited by the epidemic: the specimens thus procured included the waters of several different companies: some of the waters were obtained from *the sources of supply*, others *from service pipes*, some *from wells and pumps* at the time and in neighbourhoods in which cholera was pre-

valent, some were procured from *the deeper springs and wells in and near London,* in order to serve as standards of comparison; lastly, a few samples were obtained *from tanks, water butts, and cisterns,* in order to show the effect of those receptacles on the condition of the water stored in them.

The results of the Microscopical Examination of these different waters I propose to embody under the following separate heads:—

(1.) Report showing the results of the microscopical examination of different waters obtained from houses, one or more of the occupants of which were either affected with or had died from cholera.

(2.) Report showing the results of the microscopical examination of different specimens of well and pump water procured in neighbourhoods in which cholera was prevalent.

(3.) Report showing the results of the microscopical examination of different waters from Sandgate, collected during the prevalence of cholera.

(4.) Report showing the results of the microscopical examination of different samples of water obtained from the service pipes of several of the metropolitan water companies.

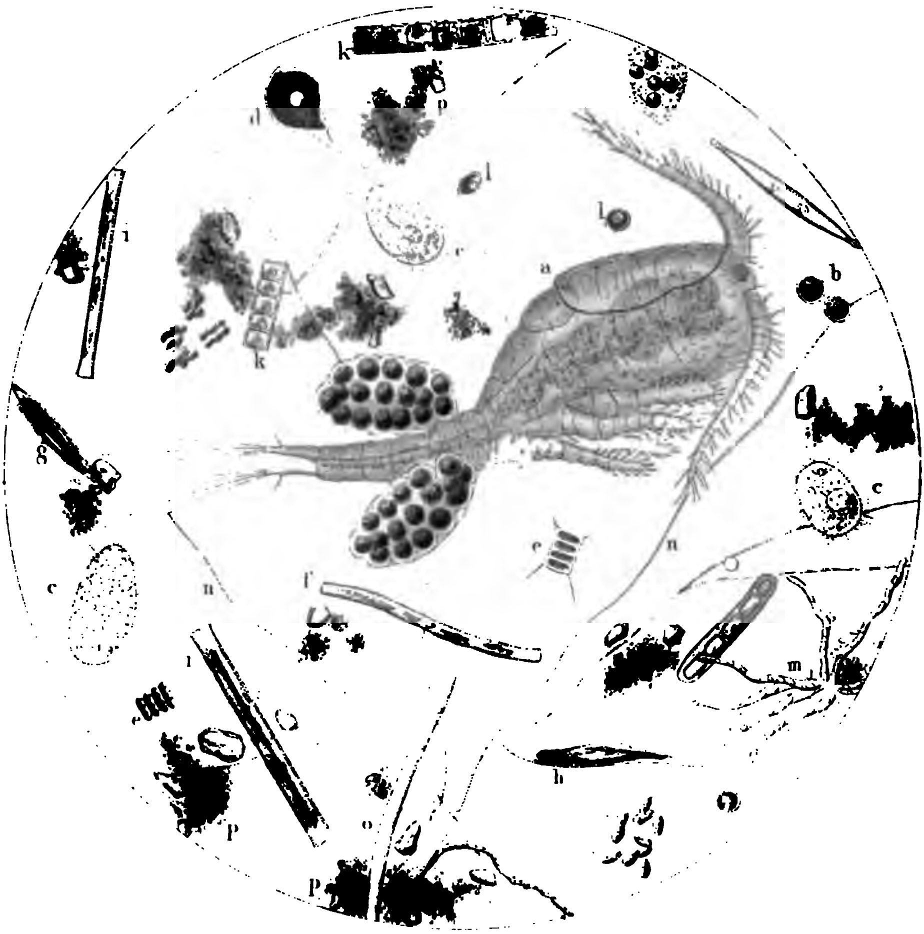
(5.) Report showing the results of the microscopical examination of water stored in cisterns, butts, and tubs, with remarks on the state of those receptacles and their influence on the purity of water.

(6.) Report showing the results of the microscopical examination of the water of the Thames, Lea, and New River.

(7.) Report showing the results of the microscopical examination of certain deep spring and well waters situated principally in and near London.

FROM WATER OF NEW RIVER COMPY.

(from Cistern)



a *Cyclops quadricornis*	f *Nitzschia Sigmoidea*	l *Peculiar rolling spherular bodies*
b *Ova of Same*	g *Pinnularia radiosa*	m *Germinating Fungus*
c *Paramecia*	h *Pleurosigma acuminatum*	n *Threads of slender Fungus*
d *Euglena longicauda*	i *Synedra Ulna*	o *Spicula of Fresh Water Sponge*
e *Scenedesmus quadricauda*	k *Melosira varians*	p *Organic debris & Earthy matter*

(1.) REPORT showing the RESULTS of the MICROSCOPICAL EXAMINATION of different WATERS obtained from HOUSES, one or more of the OCCUPANTS of which were either affected with or had died from CHOLERA.

The samples were taken from the taps of the cisterns in the ordinary way, without regard to the time at which the water was turned on. They are, therefore, fair average samples of the water as used by the inhabitants of the houses from which they were procured. This should be clearly understood, because, although in the analyses we speak of sediments and residues, these represent no larger amount of organic matter and other impurities than are actually consumed, the component parts of these sediments being so suspended in the water that some hours are necessary for their complete subsidence.

The following SAMPLES were procured from Houses supplied by THE GRAND JUNCTION COMPANY.

3, *South Row, Golden Square.*—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

In this House there were Three Deaths.

There were detected in this water, after subsidence, two or three euglenæ, several of the brown rolling lenticular animalculæ elsewhere referred to, which I cannot identify with any described in works, and two or three other minute infusoria. The residue which collected at the bottom of the glass was not inconsiderable, and there were present in it the following living organic productions:—one small annelid, anguillula fluviatilis, four or five rotifers, one paramecium, a great many of the productions known as pandorina morum in all stages of growth, a few of the peculiar brown rolling bodies above referred to, scenedesmus quadricauda, a great many frustules of synedra and naviculæ, and a few of the diatoma, asterionella formosa.

5, *South Row, Golden Square.*—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

Three Deaths from Cholera.

This water was tolerably clear and bright, and after having stood at rest for 24 hours there was but little visible sediment. There were observed in the water itself a few small infusoria, including three or four euglenæ and monads, also a few sporules of a fungus, but rather many of the peculiar brown rolling bodies or animalculæ. The residue was rather small, and in it were noticed all those organic productions, more or less characteristic of the water of the Grand Junction Company, as species belonging to the following genera—pandorina, paramecia, two species, vorticella, oxytricha, coleps, the brown rolling animalcula, many asterionellæ and naviculæ, especially A. formosa, N. amphisbœna, N. sphærophora, and fragillaria capucina. Fig. 1.

and diatomaceæ were seen, belonging to the genera pandorina, oxytricha and monas, pleurosigma, fragillaria, and meloseira, as well as some green threads of a conferva.

10, *Portland Mews, Portland Street, Golden Square.*—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

In this House there occurred Three Deaths from Cholera, and there were two other persons lying ill with that disease.

There were observed in the fluid part of this water, after subsidence, four or five of the brown rolling animalcule, a uvella, and a very few small infusoria, chiefly monads. The sediment was rather considerable, and contained many infusoria, some of large size, an oxytricha, one or two uvellæ, an annelid, a polyarthra, and many vorticellæ, as also a few frustules of synedra, and several of the masses of green motionless sporules, and a considerable quantity of the slender fungus; lastly, there was a good deal of brown granular organic matter. The cistern in this case was placed below the ground floor, and the water had to be raised by means of a pump.

9, *Broad Street, Golden Square.*—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

Six Deaths from Cholera.

In this water, after subsidence, several infusoria were seen, two or three of the usual species of polyarthra, remarkable for the sudden jerking leaps which it took, a few monads, and two or three of the brown animalcula. The residue contained a considerable number of infusoria of the genera vorticella, rotifer, oxytricha, uvella, and also some of the brown animalcules; amongst the diatomaceæ were a great many frustules of a small oval pleurosigma and several of synedra ulna; also many stationary bunches of green oval sporules.

6, *Allen Street, Clerkenwell.*—Collected 4th October 1854, by G. Glover, Esq.

Two Deaths.

This water was pretty clear, but it threw down a blackish sediment visible to the naked eye. In the water, after subsidence, two free vorticellæ were seen, as well as three or four other infusoria. The sediment deposited was very large, and consisted chiefly of organic matter, remnants of Cyclops shells, numerous vorticellæ, a large number of rotifera, a good many oxytrichæ belonging to three different species, a few actinophrydes, an annelid, and one or two large euglenæ, besides which there were a few small frustules of diatomaceæ, scenedesmus quadricauda, and a great deal of the slender fungus; there were also several large fatty masses in this water visible to the eye, about which a species of fungus (leptomitus?) was growing; the masses appeared like muscular fibre degenerated into fat.

3, *Allen Street, Clerkenwell.*—Collected 4th October 1854, by G. Glover, Esq.

Five Deaths.

In this water, after subsidence, there were seen one or two small infusoria and two synedras. The residue was very considerable, and

consisted chiefly of organic matter, dead and living; there were a considerable number of infusoria, especially actinophrydes, shells of Cyclops, oxytrichæ, coleps, uvella, and polyarthra, a few of the brown animalcule, and some vibriones. The diatomaceæ present included a good many frustules of synedra ulna, cocconeus placentula, navicula, gomphonema, fragillaria, and cymbella, also two species of pleurosigma; there were likewise single large green oval and moving sporules, and three or four groups of stationary sporules, a good many green threads of conferva, and much of the slender fungus.

15, *Broad Yard, Clerkenwell.*—Collected 4th October 1854, by G. Glover, Esq.

One Death.

In this water, after subsidence, three or four small infusoria only were seen, but the sediment deposited was rather considerable, and in it a great many infusoria and other organic productions were found; amongst the infusoria were numerous actinophrydes, two or three species of oxytrichæ, one very large, a few of what appeared to be the brown animalcule, but dead and motionless, many granular masses of vibriones, and great numbers of the same loose; in addition to the infusoria, there were rather many diatomaceæ of the genera navicula, two species of synedra; lastly, one small mass of the fatty animal matter already noticed, with the fungus growing round it, was likewise seen.

13, *Broad Yard, Clerkenwell.*—Collected 4th October 1854, by G. Glover, Esq.

One Death.

Three or four small infusoria and one oxytricha were seen in the water after subsidence. The sediment deposited was rather considerable, and of a light yellow colour; it contained a good many infusoria, principally of the genera actinophrys, uvella, and oxytricha, there being three different species belonging to the last named genus; there were also a few vibriones, and many of the peculiar brown animalcule, dead; the diatomaceæ were abundant, and in great variety; two species of pleurosigma were noticed, synedra ulna, cocconeis placentula, and a species of navicula; there was also much of the slender fungus, and many fragments of decaying vegetable tissue.

The following Samples were taken from Houses supplied by The Lambeth Company.

111, *Cornwall Road.*—Collected 5th September 1854, by Dr. Hassall and Dr. Thomson.

One Death from Cholera.

This water was bright and clear to the eye, but numerous entomostraceæ were seen swimming about in it; after having stood at

39, *Broad Street, Golden Square.*—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

Three Deaths occurred in this House.

In this water, after subsidence, the following infusoria were noticed: polyarthra, three or four; pandorina morum, several; one or two small euglenæ, and one only of the brown rolling animalculæ. In the sediment, which was not very considerable, there were rather many infusoria, as well as other organic productions: the following were observed, a cyclops, and two acarus-like entomostracans, three or four euglenæ, many pandorinæ, hundreds of asterionellæ, threads of fragillaria capucina and meloseira varians, scenedesmus quadricauda, pediastrum heptactis, and a closterium.

13, *Marshall Street, Golden Square.*—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

Four Deaths and Two other Cases.

Some of the brown animalculæ were detected in this water after subsidence, as well as several pandorinæ rolling actively about. The sediment was rather considerable, and in it were detected dozens of pandorina, a few large infusoria, and several of the brown animalculæ, also hundreds of asterionella formosa, a few frustules of meloseira varians and fragillaria capucina, a small closterium, and the thallus or threads of two species of fungus, that with the slender threads and the yellow fungus-like production, resembling the stems of a species of anthophysa.

14, *Cambridge Street, Golden Square.*—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

Two Deaths occurred in this House.

This water deposited scarcely any sediment; eight or nine minute infusoria, including two euglenæ, were seen in it after subsidence, but none of the brown animalculæ were detected although sought for a long time; scarcely any organic productions of any kind were observed in the minute quantity of sediment which was deposited, neither diatomaceæ nor the brown animalculæ, and indeed only a few small infusoria.

The following SAMPLES were procured from Houses supplied by THE NEW RIVER COMPANY.

23, *Peter Street, Golden Square.*—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

In this House there were Six Deaths.

A few infusoria were seen in this water after subsidence, including two of a species of polyarthra, which was the largest animalcula seen, and only one of the brown animalcules. The residue was rather considerable, and contained a good many of the brown lenticular animalcules, but not many other infusoria. Those that were noticed belonged to the genera paramœcium, oxytricha, and euglena; amongst the diatomaceæ were frustules of pleurosigma acuminatum, Nitzschia

22, *Carter Street, St. Peter's, Walworth.*—Collected 16th September 1854, by Dr. Hassall and Mr. Walker.

One Death only in this House.

This water was clear and bright, but it contained a good many large entomostraceæ, of which there were two species; after subsidence, but very few infusoria were seen, and these all very small; the residue was inconsiderable, and contained but few organic productions, a piece of shell of daphnia, several paramecia, one lagenella, two threads of conferva, green moving sporules, spiculæ of sponge, and some threads of the slender fungus.

The following SAMPLES were procured from Houses supplied by SOUTHWARK AND VAUXHALL COMPANY.

154, *Waterloo Road.*—Collected 5th September 1854, by Dr. Hassall and Dr. Thomson.

One Death from Cholera.

This specimen was decidedly dull and opalescent to the eye, as contained in a Winchester quart bottle, and there were numerous entomostraceæ swimming about in it. There were detected in the water itself, after subsidence, a few small infusoria, while the residue, which was very considerable, abounded with living organic productions, infusoria especially, of the genera stentor, rotifer, actinophrys, acineta, amœba, oxytricha, coleps, vorticella, and paramecium; amongst the diatomaceæ were a great many frustules of the Nitzschia sigma, with a few of N. amphyoxis, many of synedra minutissima, some of cyclotella operculata and meloseira varians; amongst the desmideæ were scenedesmus acutus S. quadricauda, and pediastrum boryanum; while in the dead organic matter were spiculæ of sponge, and the exuvial masses before referred to, intermixed with, and lying amongst which, were many threads of the yellow fungus alluded to as occurring in the water from 29, Wootton Street, as well as in other waters. Fig. 3.

131, *Waterloo Road.*—Collected 5th September 1854, by Dr. Hassall and Dr. Thomson.

Two Deaths from Cholera.

Many entomostraceæ were swimming about in this water, and there were discovered, by means of the microscope, after complete subsidence, rather many small but active infusoria, while in the residue, which was considerable, the organic productions met with were for the most part similar to those of the previous sample, and included many infusoria, as oxytrichæ and paramecia, and one rotifer; amongst the desmideæ were scenedesmus quadricauda, scened. lunaris, and one or two species of pediastrum, while amongst the diatomaceæ were a great many frustules of Nitzschia sigma and cyclotella operculata; lastly, fragments of vegetable tissue and the yellow fungus were noticed.

sigmoidea, synedra ulna, and fragillaria capucina; and, lastly, a few masses of circular green sporules, stationary, and imbedded in a mucous base, a few spiculæ of sponge, and much dead organic matter, mixed up with a great many threads of the usual slender fungus, were noticed.

9, *Hopkins Street, Golden Square.*—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

Eight Cases occurred in this House.

Several of the entomostracan, Cyclops quadricornis were seen in this water, and after subsidence many of the brown animalculæ, as well as one or two other small infusoria; the sediment deposited was scarcely perceptible, but it contained a good number of the brown animalcule, and a few other small infusoria, of the genera paramecia and euglena; also scenedesmus quadricauda, and amongst the diatomaceæ frustules of pinnularia radiosa, pleurosigma acuminatum, synedra ulna, meloseira varians, Nitzschia sigmoidea; also sporules of fungus germinating, threads of slender fungus, and fragments of vegetable tissue. Fig. 2.

11, *Hopkins Street, Golden Square.*—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

In this House Three Deaths and Two Cases occurred.

Four or five of the brown animalcules were the only organic productions met with in this water after subsidence, but in the sediment which was small the following productions were noticed:—a Cyclops, and a second species of entomostracan, the name of which was not ascertained, several paramecia, a few smaller infusoria, mostly monads, and a considerable number of the brown animalcule; amongst the diatomaceæ were frustules of synedra ulna, one or two of a small navicula, a thread of fragillaria, and a pleurosigma; amongst the desmideæ, scenedesmus quadricauda was rather plentiful, as well as many masses of the circular and oval green stationary sporules, so commonly present in samples of the water of this Company.

5, *Berwick Street, Golden Square.*—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

In this House there were Five Deaths and Two Cases of Cholera.

This was the specimen in which the brown rolling animalcula were first observed; many of these were present in this water after subsidence, as well as one or two other small infusoria of two or three different kinds, including a species of the genus uvella. In the residue, which was small, there were observed one of the eel-like annelids, anguillula fluviatilis, a brachionus, oxytrichæ, and a few monads; frustules of naviculæ and meloseira, and a few of the motionless bunches of green sporules.

3, *Broad Street, Golden Square.*—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

Three Deaths took place in this House.

There were discovered in this water, after subsidence, several of the brown rolling animalcule, as well as four or five other minute infusoria; while in the residue, which was but small, a few infusoria

15, *Eaton Street, Waterloo Road.*—Collected 5th September 1854, by Dr. Hassall and Dr. Thomson.

One Death from Cholera.

This water was also decidedly opalescent, and contained several entomostraceæ; it also threw down a very considerable sediment. There were detected in the very first drop examined, after subsidence, several small infusoria, including one polyarthra, while the sediment swarmed with infusoria and other organic productions; species belonging to the following genera were observed—actinophrys, a great many, rotifer, vorticella, oxytricha, paramecium, and coleps, synedræ and naviculæ. Amongst the dead organic matter noticed were fragments of vegetable tissue, besides which there was the yellow fungus-like production resembling anthophysa.

29, *Wootton Street, Waterloo Road.*—Collected 5th September 1854, by Dr. Hassall and Dr. Thomson.

Two Deaths from Cholera.

This water, as contained in a clear glass Winchester quart bottle, was somewhat dull and opalescent, it swarmed with entomostraceæ, and after having stood for some time a considerable sediment collected at the bottom of the conical glass into which it was poured. There were detected in the water itself, after complete subsidence, many small animalcules belonging to the genera coleps, euglena, paramecium, and monas, as well as three or four naviculæ. The animalcules were so numerous that commonly four or five, and often more, were present in every drop of the water subjected to examination. The sediment was composed, as it is in nearly all cases, in part of dead and in part of living organic matter, animal and vegetable. Amongst the living were a great variety of infusoria, mostly of the genera oxytricha, coleps, paramecium, and pandorina, a great many diatomaceæ, especially meloseira varians, meloseira nummuloides, cyclotella operculata, and many of the usual Nitzschia, N. sigma; some desmideæ, as different species of scenedesmus, especially S. quadricauda, and pediastra, as P. hexactis. In addition to the above there were the two usual species of fungus, the one with yellow branched threads, the other with very slender branched threads, also a few filaments of an oscillatoria. The two species of fungus noticed are of very common occurrence in many of the more impure waters. Amongst the dead organic matter were many fragments of vegetable tissue, hairs of animals, a dead entomostracan, and shells of the same.

10, *Berkeley Terrace, St. Peter's, Walworth.*—Collected 16th September, 1854, by Dr. Hassall and Mr. Walker.

Two Deaths from Cholera.

This water contained several entomostraceæ, chiefly of the genera Cyclops, visible to the naked eye, while in it, after subsidence, by means of the microscope, there were seen four or five small infusoria. The residue was not considerable, but it contained several paramecia,

a good many oval euglenæ, and three or four of another species of the same genus (E. longicauda), as well as several of a third species, many amabæ, and one or two vorticellæ; there were also present the two usual species of scenedesmus in great numbers, a good many frustules of the usual cyclotella, a few of synedra ulna, two or three lagenellæ, and a great many brown motionless sporules having a festooned border, and which are of rather common occurrence in water, also several branched threads of drapernaldia.

25, *Bollinbrooke Row, St. Peter's, Walworth.*—Collected 16th September, 1854, by Dr. Hassall and Mr. Walker.

There were Two fatal Cases in this House.

This water was dull and opalescent, and contained several entomostraceæ swimming about, and of course plainly visible to the naked eye, while in it, after subsidence, there were detected, with the microscope, a considerable number of infusoria, including one or two polyarthræ, several pandorinæ, oval euglenæ, and a rotifer resembling a species of triarthra. The residue was very considerable, and abounded in organic living productions, representing the different orders entomostraceæ, infusoria, desmideæ, diatomaceæ, and fungi. Amongst the entomostraceæ were two daphnias; amongst the infusoria, a rotifer, brachionus, polyacanthus, euplotes charon, amplileptus, paramecium, and many actinophrydes; amongst the desmideæ, closterium lunula, pediastrum boryanum, scenedesmus quadricauda; sc. acutus and sc. obtusus were the most common; amongst the diatomaceæ, a very great many frustules of cyclotella operculata and synedra minutissima, and a few of pleurosigma; and amongst the fungi were the two usual species, that with slender branched filaments, and that with yellow threads; lastly, there were many circular green sporules, free, but motionless, and two or three broken fragments of muscular fibre. Fig. 4.

Flora Cottage, Windmill Road, Bermondsey.—Collected 16th September 1854, by Dr. Hassall and Mr. Walker.

Two Deaths and Five Cases of Cholera besides.

Water very dull and opalescent, and in it, after subsidence, there were seen a great many infusoria swimming about, some large, including paramecia and oxytricha, and a rolling oval granular animalcule, very common in water from the River Thames, and in that of the Southwark and Vauxhall Company; there were also a few entomostraceæ visible to the naked eye. The residue was very considerable, and contained a great number of actinophrydes, very many frustules of cyclotella operculata, the usual Nitzschia, N. sigma, as well as many micrasterias, and much of the yellow fungus.

Batchelor's Guano Manufactory, 9, *Cottage Row, St. James', Bermondsey.*—Collected 16th September 1854, by Dr. Hassall and Mr. Walker.

In this House there were Two fatal Cases.

This water was somewhat turbid and opalescent, and in the first cell full of it placed under the microscope, after subsidence, several

FROM WATER OF SOUTHWARK & VAUXHALL COMP^{Y}.

(from Cistern)

Magnified a [illegible], b [illegible], *and the rest* [illegible] *diam.*

a *Blood red Annelide.*
b *Brachionus polyacanthus.*
c *Euplotes charon.*
d *Paramoecia.*
e *Amphileptus.*
f *Actinophrys Sol.*
g *Actinophrys viridis.*
h *Pediastrum Boryanum.*
i *Closterium Lunula.*
k *Scenedesmus quadricauda.*
l ——— *acutus.*
m ——— *obtusus.*
n *Cyclotella operculata.*
o *Nitzschia Sigma.*
p *Synedra minutissima.*
r *Melosira varians.*
s *Threads of Slender Fungus.*
t *Minute star shaped Bodies.*
u *Organic & Earthy matter.*

small infusoria and frustules of diatomaceæ were seen; amongst others, a few groups of frustules of synedra minutissima, a considerable number of frustules of cyclotella operculata, and green and brown stationary sporules. The residue was considerable, and in it there were seen one large cyclops, a large red-jointed worm, a great many actinophrydes, many large oxytrichæ, and numerous pediastra.

9, *Prospect Row, St. James', Bermondsey.*—Collected 16th September 1854, by Dr. Hassall and Mr. Walker.

Father and Daughter died in this House.

This water was also somewhat turbid and opalescent, and in it, after subsidence, a good number of infusoria were seen by means of the microscope, including several euglenæ, polyarthræ, and a scenedesmus, while swimming in the water, and visible to the naked eye, were several entomostraceæ. The residue deposited was considerable, and it was found to be made up to a considerable extent of the same elements and productions as that of most of the other specimens of Southwark and Vauxhall water. Amongst those specially noticed were some antinophrydes, a few pandorinæ, and a great many desmideæ and diatomaceæ, including, amongst the former three species of pediastrum, scenedesmus lunaris, sc. quadricauda, and a closterium, and amongst the latter a great many frustules of cyclotella operculata, and Nitzschia sigma, a few frustules of diatoma vulgare, gomphonema capitatum, and navicula amphisbœna, many bunches of frustules of synedra minutissima, a thread of meloseira varians, and a few frustules of a species of amphora, much yellow fungus, and portions of altered muscular fibre.

13, *Clanden Street, Newington.*—Collected 26th September 1854, by Dr. Headlam Greenhow.

Two fatal Cases of Cholera and Two ill of Diarrhœa.

A four-ounce bottle only of this water was obtained, and in the deposit from it there were seen a great many frustules of the usual cyclotella, one or two short threads of meloseira varians, a few frustules of a gomphonema, and of other diatomaceæ; amongst the infusoria were several of the olive-coloured euglenæ, many monads, and one or two other infusoria, likewise much of the yellow fungus, and one bunch of thallus, resembling that of penicilium glaucum.

29, *Clanden Street, Newington.*—Collected 26th September 1854, by Dr. Headlam Greenhow.

Two fatal Cases of Cholera, and One ill of Diarrhœa.

A six-ounce bottle only of this water was procured, and yet the sediment was found to abound in all the organic productions of various kinds, so commonly present in the water of the Southwark and Vauxhall Company—rotifers, a great many, actinophrydes, oxytrichæ, coleps, euglenæ, a great many diatomaceæ of the genera cyclotella and Nitzschia, especially N. sigma, also scenedesmus lunaris.

28, *Clanden Street, Newington.*—Collected 26th September 1854, by Dr. Headlam Greenhow.

One fatal Case of Cholera, and One ill of Diarrhœa.

In this water, although, as in the case of the two previous samples, the quantity obtained was small, all the usual productions characteristic of the water of the Southwark and Vauxhall Company were present in great abundance, including a great many actinophrydes, &c.

The following SAMPLES were obtained from Houses supplied by THE CHELSEA COMPANY.

3, *Eatley's Buildings, Manor Street, Chelsea.*—Collected 27th September 1854, by Dr. Hassall and Dr. Headlam Greenhow.

One Case of Cholera and Four of Diarrhœa in this House.

This water was not thoroughly bright, and in it, after subsidence four or five minute infusoria were detected; there was but little deposit, and only a few infusoria were seen, these being chiefly monads; in addition, a few frustules of cyclotella operculata, synedra munitissima, three or four fronds of scenedesmus, and a little of the yellow fungus were discovered.

53, *Queen's Road West, Chelsea.*—Collected 27th September 1854, by Dr. Hassall and Dr. Headlam Greenhow.

Two Deaths and Two Cases of Diarrhœa.

There were detected in this water, after subsidence, a uvella, brown oval and circular moving sporules, and one or two small infusoria. The quantity of sediment was small, but it contained a good many infusoria and other productions, a cyclops and a daphnia, a rotifer, an annelid, several actinophrydes, green oval uvellæ, and many infusoria of the genus coleps, with a few euglenæ of two different species, monads, and brown moving sporules, including a species of lagenella; there were also large numbers of the fronds of scenedesmus, a few pediastra, many frustules of cyclotella operculata, a few of synedra munitissima, and much of the yellow fungus.

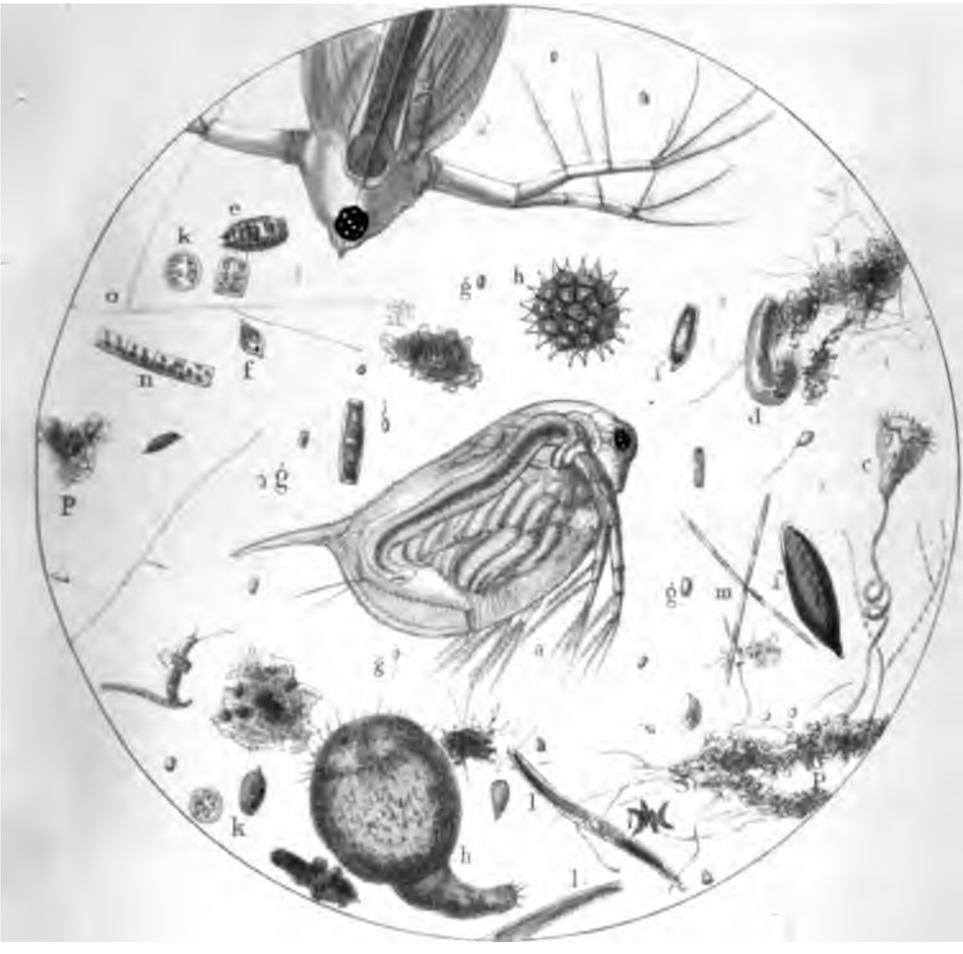
5, *Bolton's Gardens, Chelsea.*—Collected 27th September 1854, by Dr. Hassall and Dr. Headlam Greenhow.

Five Deaths; Diarrhœa general.

In this water, after subsidence, there were a great many entomostraceæ swimming about, principally daphnia pulex, as well as rather many infusoria, the latter included three or four euglenæ, a paramecium, one polyarthra, two yellow rolling spherules, and other still more minute animalcula. The residue was rather considerable, and contained all the same elements as the Southwark and Vauxhall

FROM WATER OF CHELSEA COMPANY. Pl. 5.

(From Cistern.)



a *Daphnia Pulex mas*	e *Coleps hirtus*	k *Cyclotella operculata*
a' ——— *fem*	f *Euglena viridis*	l *Nitzschia Sigma*
b *Rotifer in peculiar state*	g *Monads*	m *Synedra minutissima*
c *Vorticella convallaria*	h *Pediastrum Boryanum*	n *Melosira varians*
d *Oxytricha*	i *Scenedesmus acutus*	o *Threads of the Fungus*

p *Organic debris.*

H. Miller del. - Tuffen West lith. ... & West imp

water, only in smaller numbers. Amongst them were observed a rotifer, vorticella convallaria, oxytrichæ, coleps hirtus, euglena viridis, and monads; scenedesmus acutus, pediastrum boryanum, meloseira varians, cyclotella operculata, Nitzschia sigma, and synedra munitissima. Fig. 5.

Wink's Court, Chelsea.—Collected 16th September 1854, by Dr. Headlam Greenhow.

This water was tolerably clear and bright, but it contained many entomostraceæ swimming about in it. After subsidence, five or six small infusoria were seen, including two paramecia; rather much brownish sediment subsided, this contained broken shells of some entomostracan, a few infusoria of the genera coleps, euglena, and monas; plenty of scenedesmus, a few pediastra, a closterium, frustules of cyclotella operculata, the brown festooned sporules, and one of the usual Nitzschia N. sigma, filaments of the slender fungus, and rather much yellowish organic débris.

The following Samples were procured from Houses supplied by The East London Company.

Allen's Cottages.—Collected 7th October 1854, by Dr. Hassall and Mr. Walker.

One Death.

This water, after subsidence, was found to contain infusoria and other animalculæ, amongst which were some of the genera paramecium, coleps, and vorticella. The sediment in this case was rather copious, and contained two large paramecia, several oxytrichæ, vorticellæ and coleps; amongst the vegetable productions were to be seen rather many diatomaceæ, especially asterionella formosa, which was present in immense numbers, several frustules of pleurosigma, synedra ulna, and frustules of fragillaria capucina, also scenedesmus quadricauda, a good deal of the slender fungus, and a second species of fungus. Fig. 6.

25, *Willis Street.*—Collected 7th October 1854, by Dr. Hassall and Mr. Walker.

One Death.

In this water a small quantity of sediment only was deposited, but there were detected hundreds of minute infusoria actively swimming about, dozens of small paramecia, and one large one, two amœbæ, and a few small oxytrichæ. Amongst the diatomaceæ were a few frustules of synedra ulna, and also of another species of synedra; frustules of navicula and coconema, together with a few of the circular festooned brown sporules; two species of fungus were also present, that with the slender threads, and another larger kind with germinating sporules, most probably penicilium glaucum, together with four or five fragments of decaying vegetable tissue.

The following SAMPLES were procured from Houses supplied by THE KENT COMPANY.

5, Duke Place, Deptford.—Collected October 1854, by Dr. Hassall and Registrar of Births and Deaths for the District.

One Death occurred in this House.

Rather many monads were detected in this water after complete subsidence; there was scarcely any sediment, but in the little that did subside the following organic production were noticed: one small worm (anguillula fluviatilis), one vorticella, a few oxytrichæ, two animalculæ of the genus amphileptus, many small paramecia and monads, one brown globular moving sporule and several brown ova cases; the only desmidium seen was a small cosmarium; and of the diatomaceæ, three frustules only were noticed, but there was a good deal of the slender fungus.

97, *New Street, Deptford.*—Collected October 1854, by Dr. Hassall and Registrar of Births and Deaths for the District.

Six Deaths in this House.

Rather many infusoria were seen in this water after subsidence, and these of larger kinds than those in the preceding sample. The residue was also rather considerable, and contained a great many animalculæ of the genus amphileptus, three loricated infusoria, allied to rotifer, one jointed worm, about twenty vorticellæ, several oxytrichæ of three or four different species, large and small, numerous rather small paramecia, two or three actinophrydes, a few monads, and three or four animalculæ of the genus polyarthra. No diatomaceæ were seen, and only one scenedesmus. Fig. 7.

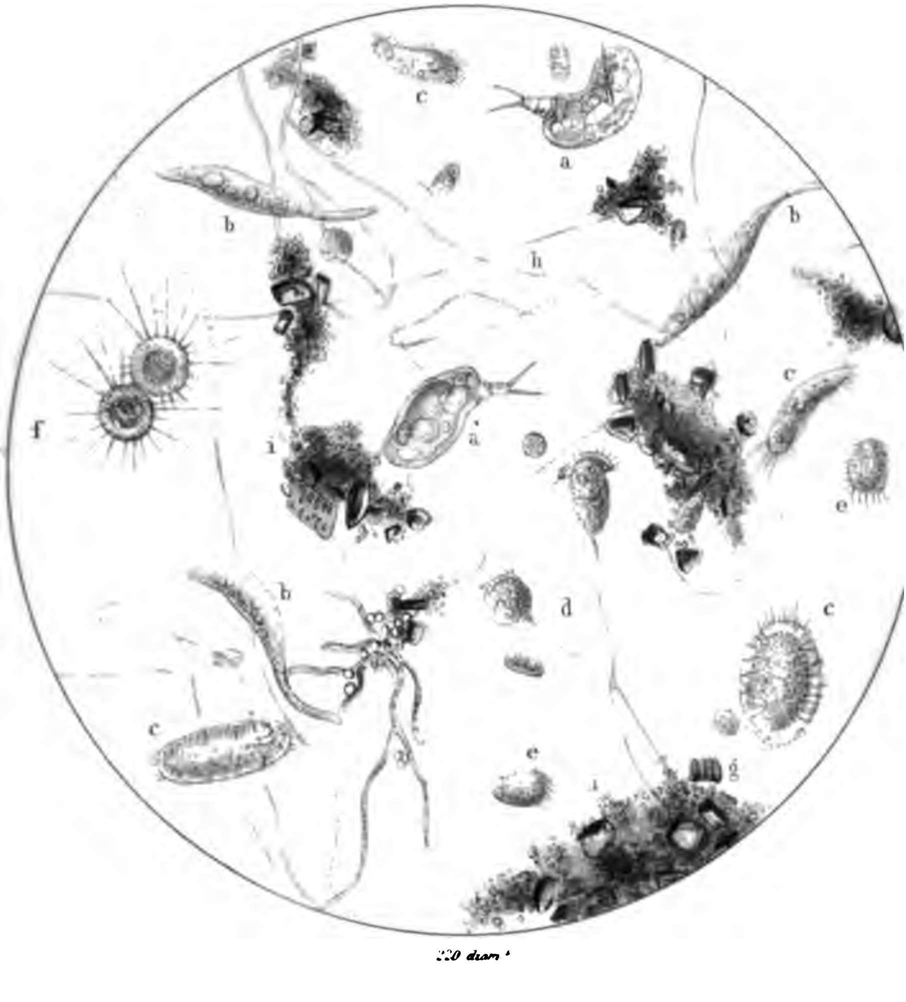
From an examination of the preceding Microscopical Analyses of water procured from cholera houses, the following conclusions may be deduced:—

1st. That the whole of the numerous specimens of water subjected to examination contained organic matter, dead and living, animal and vegetable, including, for the most part, several distinct classes of productions, as annelidæ, entomostraceæ, infusoria, conferveæ, desmideæ, diatomaceæ, and fungi, as well as hairs of animals, starchy matter of different kinds, and dead and decaying fragments of vegetable tissues.

2d. That the quantity and kinds of organic matter varied considerably in different cases, but were usually more or less constant for the same water.

3d. That the waters which contained the largest amount of organic matter, and in which the greatest number and variety of productions, dead and living, were discovered, were those from houses supplied by *the Southwark and Vauxhall Company*. The whole of the samples of this water examined abounded in living animalculæ of different genera and species, in desmideæ, in certain very characteristic species of diatomaceæ, and in fungi. They likewise contained a large quantity of dead organic matter, amongst which were frequently to

FROM WATER OF KENT COMPANY. Pl.
(From Cistern)



220 diam.

a. a. *Rotifers*	d *Vorticella ampullaria*	g. *Scenedesmus quadricauda* ×
b. *Amphileptus*	e *Polyarthra*	h *Threads of slender Fungus*
c. *Oxytricha. 3 Species*	f *Actinophrys Sol*	i *Organic debris & dirt*

[illegible] del. Tuffen West lith. — Dr A. H. Hassall direxit — Ford & West imp.

for a time any degree of suspicion, this was the brown flat or lenticular actively moving body represented in Fig. 8, and which was present in nearly all the waters obtained in the Golden Square district, as well as in some of the others. But having since met with this production in waters supplied to houses and districts in which no cases of cholera occurred, and moreover, not meeting with it in any of the ejections of cholera, no grounds whatever exist for attaching any serious importance to its presence in water in relation to cholera.

In some of the waters vibriones were discovered, and since these invariably abound in the rice-water dejections of cholera, it might be inferred that their presence was of more consequence, and this, indeed, may possibly be the case, but since they are present, more or less, in many impure waters at all times and in all seasons, it is quite clear they cannot originate the disease. In some cases the vibriones, which afterwards become developed in such vast quantities in the rice-water discharges even whilst contained in the small intestines, may possibly have been introduced through the waters drank. We are not, however, to infer that the presence of living organic productions in water is of no consequence in relation to cholera; directly, we believe that they are of little importance, but indirectly, and as evidences of the impurity of the waters in which they are found, we consider that their presence is of very considerable importance.

8th. That amongst the productions present in the water of the Southwark and Vauxhall, the Lambeth, and the West Middlesex Companies, are some which are found only in brackish waters; these are chiefly diatomaceæ, especially the following—Nitzschia sigma, meloseira nummuloides, and coscinodiscus eccentricus. This is a very important fact, and one to which we shall hereafter refer more at length.

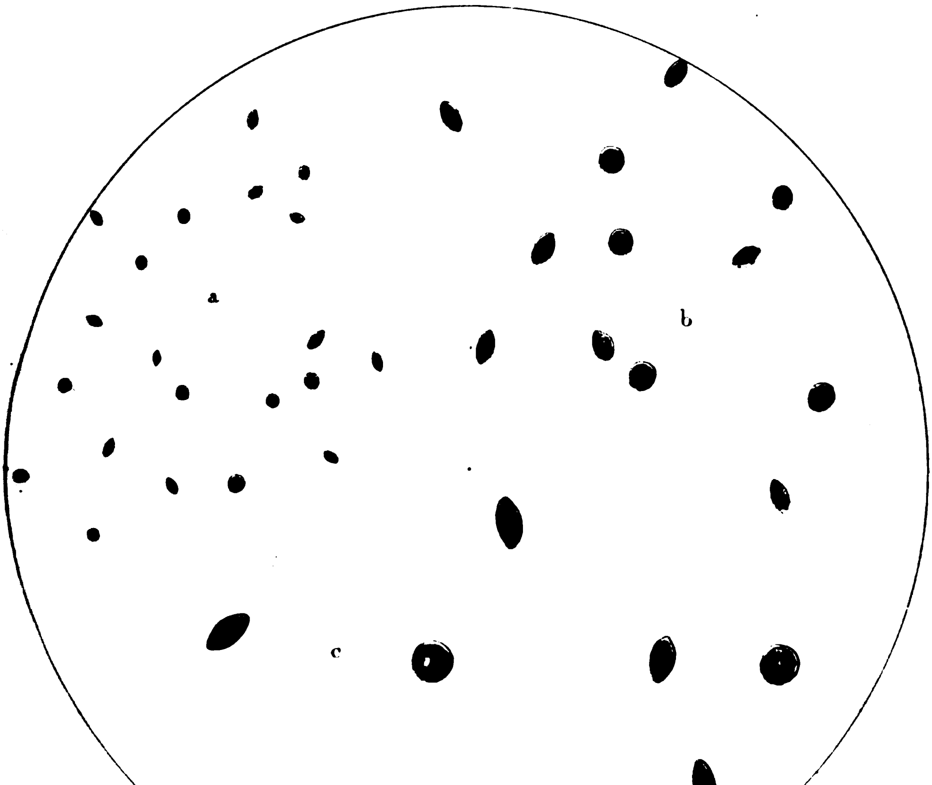
Finally, it appears, as the general results arising out of the microscopical examination of the waters obtained from cholera houses:

That the specimens taken from cisterns supplied by the Southwark and Vauxhall Company were very impure, indeed, far more so than any of the other waters examined, some of them being demonstrably contaminated with fœcal matter.

That the waters of the other companies were all of them more or less impure, the comparatively purest of the whole, being the freest from organic productions, was that supplied by the Lambeth Company. The contrast furnished by the water now supplied by that Company and that which it formerly furnished, taken from the river at Lambeth, is most marked; the condition of the water of the old supply was even worse than that of the water now distributed by the Southwark and Vauxhall Company.

That the microscopical examination of the different waters obtained from houses visited by cholera throws no special or direct light upon the production of that epidemic.

PECULIAR BROWN ACTIVELY MOVING LENTICULAR BODIES.



Magnified a [illegible] b [illegible] *and* c [illegible] *diam.*

Found in Several of the Waters from the Golden Square district.

of three or four different kinds, including a few small oxytrichæ, a single vorticella, monads, and several animalculæ three or four times larger than monads, having a long tail-like appendage, filaments and sporules of fungus, a bunch of ova cases, and a great many circular brown dotted corpuscles or bodies, and which were also seen in some of the other waters examined

No. 3.—From Pump in *Broad Street, Golden Square.*—Collected 17th September 1854, by Dr. Hassall and Mr. Patterson.

This water was clear and bright, the only living organic productions contained in it were rather many animalculæ of the genus monas, three or four small animalculæ, like a species of amphileptus, and a few ova cases; the animalcules were however present in sufficient quantity to show that this water could not be considered to be pure. This is the water to which Dr. Snow, during the recent outbreak of cholera, so strongly drew attention. Fig. 9. See Analysis of Dr. Thomson.

No. 4.—*Wilderness Row, Goswell Road.*—Collected by G. Glover, Esq., 4th October 1854.

Water of a decidedly greenish hue, probably from contamination by a cesspool; no infusoria of any kind were seen in it after subsidence, but it furnished a small quantity of blackish sediment, which contained a few infusoria, oxytrichæ of two different species, and other animalculæ; also about a dozen small diatomaceæ, belonging to the genus pleurosigma, two or three small fragments of vegetable tissue, one head of a fungus of the genus dactylium, and a good many dotted brown circular bodies, referred to under the sample No. 2.

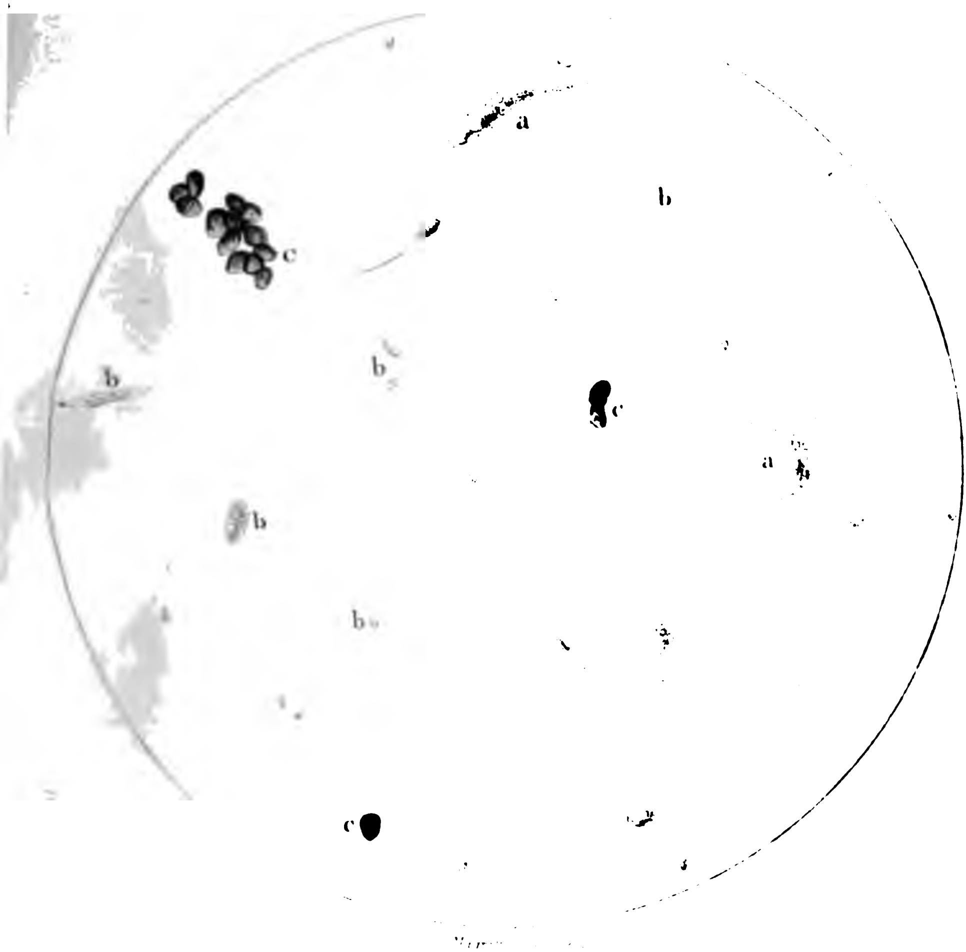
No. 5.—From Well in *Bayley's Yard, Allen Street, Clerkenwell.*—Collected 4th October 1854, by G. Glover, Esq.

The sediment deposited from this water was very considerable, and amongst it were several of the fatty looking masses, seen in the water from 15, Broad Yard, surrounded by fungus. The sediment swarmed with infusoria, and included a great many entomostraceæ of the genus Cyclops, C. quadricornis, dead and living, and animalculæ, including actinophrys sol, coleps hirtus, and amphileptus faciola, as well as two or three other kinds, the names of which could not be ascertained, but one of which was a species of eurocentrum. Amongst the diatomaceæ were frustules of pleurosigma attennatum, synedra ulna, and of a navicula, as well as of asterionella formosa. Lastly, there were three different species of fungus, and much decaying vegetable tissue. Fig. 10.

No. 6.—From Pump in *Cock's Buildings, Putney*—Collected 8th October 1854, by Dr. Hassall and Mr. Whiteman.

This water, during the prevalence of cholera in Putney, was of a decided green colour, as was observed by the inhabitants of the many houses supplied by it; this appearance had gone off somewhat at the period when the specimen was obtained, at which time cholera was

FROM WATER FROM PUMP IN BROAD S^T GOLDEN SQUARE.



a *Amphileptus* b *Monads and other Infusoria* c *Brown Ova cases.*

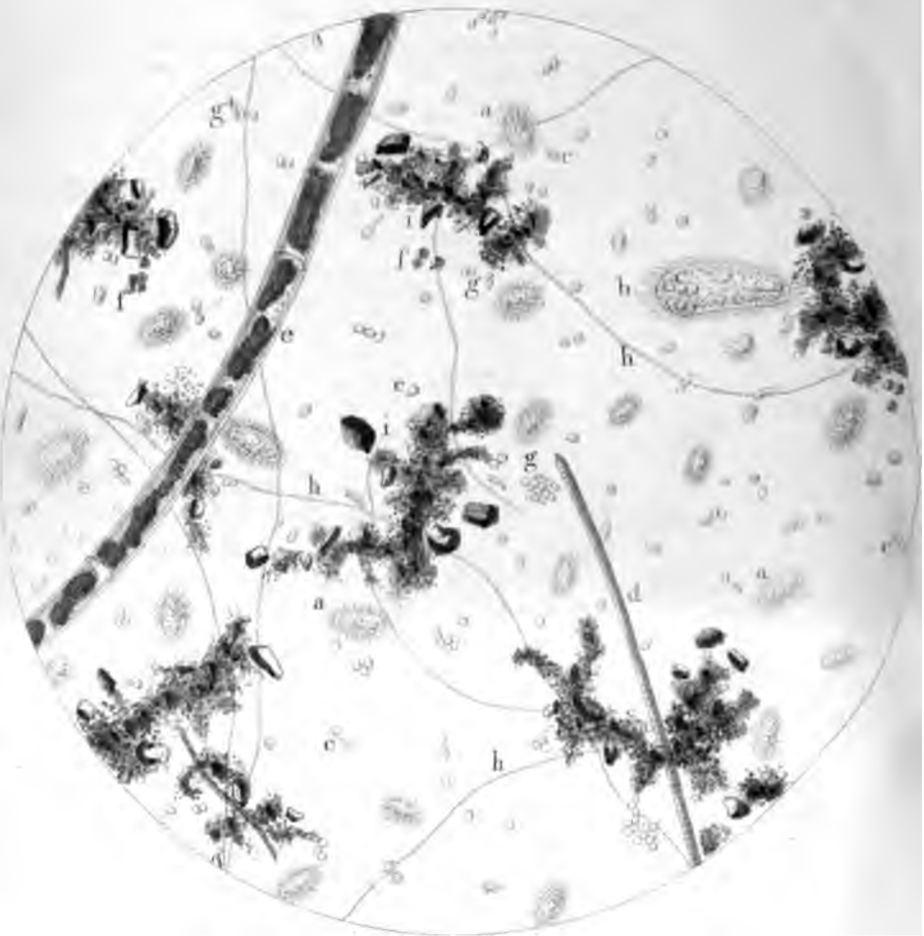
FROM WATER OF WELL, IN BAILEY'S YARD. Pl. 1
Allen Street, Clerkenwell.

Magnified Cyclops 100 the rest 220.

a. *Cyclops quadricornis*
b. *Amphileptus*
c. *Coleps hirtus*
d. *Vorticella detached from their stems*
e. *Actinophrys Sol*
f. *Urocentrum*
g. *Synedra Ulna*
h. *Pleurosigma attenuatum*
i. *Asterionella formosa*
k. *Frustules of different Diatomaceæ*
l. *Vibriones*
m. *Threads of Fungus of different Species.*
n. *Spiculæ of fresh water Sponge*
o. *Earthy & Organic matter.*

H. Miller del. Tuffen West sc. Dr A. H. Hassall direxit Ford & West Imp.

FROM WATER OF WELL AT BRASTED PL.



a. *Paramecia.*	d. *Oscillatoria.*	g. *Colourless Sporules of a Fungus*
b. *Oxytricha.*	e. *Filament of Conferva.*	h. *Slender Fungus*
c. *Monads*	f. *Green motionless Sporules.*	i. *Organic and gritty matter*

H. Miller del. ... Ford & West Imp.

also on the decline, but still it was of a greenish hue, as was clearly seen when the water was poured out into a glass tumbler; scarcely any sediment was deposited, and there was discovered, in the little that was thrown down, four or five oxytrichæ, one or two paramecia, masses and threads of the spiral vibrio, which exhibits a dotted appearance at each turn of the spire, and rather many monads. This water, from its appearance and from the account given of it, was evidently contaminated by percolation from a neighbouring cesspool, and the principal part of the organic matter present was in the fluid state, and in the form of nitrates. See Dr. Thomson's analysis.

No. 7.—From Pump in *Price's Folly, Putney.*—Collected 8th October 1854, by Dr. Hassall and Mr. Whiteman.

This water resembled the preceding in colour and appearance, but was still deeper; the source of contamination was also the same, namely, a neighbouring cesspool. Very little sediment was deposited, enough only to be just visible to the naked eye in a thin glass cell; it contained a considerable number of actinophrydes, some of the spiral vibriones before referred to, a few euglenæ, one or two small paramecia, a few small sporules and threads of fungus, and eight or ten frustules of different diatomaceæ, including navicula and gomphonema; lastly, there were a few green circular sporules aggregated into little masses, and motionless. See Dr. Thomson's analysis.

No. 8.—From Pump at 19, *Stratford Grove, Putney.*—Collected 8th October 1854, by Dr. Hassall and Mr. Whiteman.

This water was coloured like the others, but the people of the house from which it was procured fancied that it was contaminated by leakage from a gas pipe, which, however, is some distance away from it, nevertheless there is much reason to believe that the explanation given is correct, as there is no cesspool near, and as the water was always good until the gas pipe was laid down. The sediment deposited was scarcely perceptible, and in it a few monads, vibriones, and sporules of fungus only were discovered.

No. 9.—From Well at *Sevenoaks, Brasted.*—Collected 19th September 1854, by Mr. Thomas Waring.

The well is about fourteen feet deep, and uncovered, a cesspool and privy being situated about twenty-five feet from the well; it supplies ten cottages, amongst the inhabitants of which there have been numerous deaths from cholera. This water threw down a copious light brown sediment, consisting principally of organic matter; it abounded in minute infusoria, principally paramecia and monads; it also contained threads of conferva, oscillatorea, and filaments and sporules of a fungus. Fig. 11.

No. 10.—Well, *Mill Corner, Hadley.*—25th September 1854, collected by Dr. Milroy.

Water very dirty, and threw down a very large deposit; this consisted in part of grit and dirt, which was full of worm-like animalcules spirostomum ambiguum, and contained many infusoria, including a

great number of vibriones, spiral and very active, also much fungus of two different species, several large brown and dotted sporules or bodies, and a few frustules of diatomaceæ. Fig. 12.

NEWTON, WISBEACH.

The two following are specimens of the water which is usually found in the village of Newton, if wells be dug on the land side of the old sea bank, which passes through portions of this and several neighbouring parishes. The wells are from twenty to twenty-five feet deep, and when sunk to that depth, the water rises half way up. At the depth of about twenty-five feet a layer of black clay is met with.

No. 11.—From Well.—Collected 16th September 1854, by the Rev. Dr. Corrie.

This water possessed a very offensive odour; the residue thrown down was very large, and consisted principally of organic matter in a granular form, containing a few monads and other small infusoria only.

No. 12.—From Well.—Collected 16th September 1854, by the Rev. Dr. Corrie.

Water of a brownish yellow colour, and smelling very offensively, evidently from holding sulphuretted hydrogen in solution. There was a large quantity of sediment deposited, which to the eye looked like Fuller's earth, and under the microscope presented a granular texture, but no infusoria were seen.

Both these waters, from their offensive smell, were evidently much contaminated with organic matter; it is probable that this was derived from the layer of black clay above referred to.

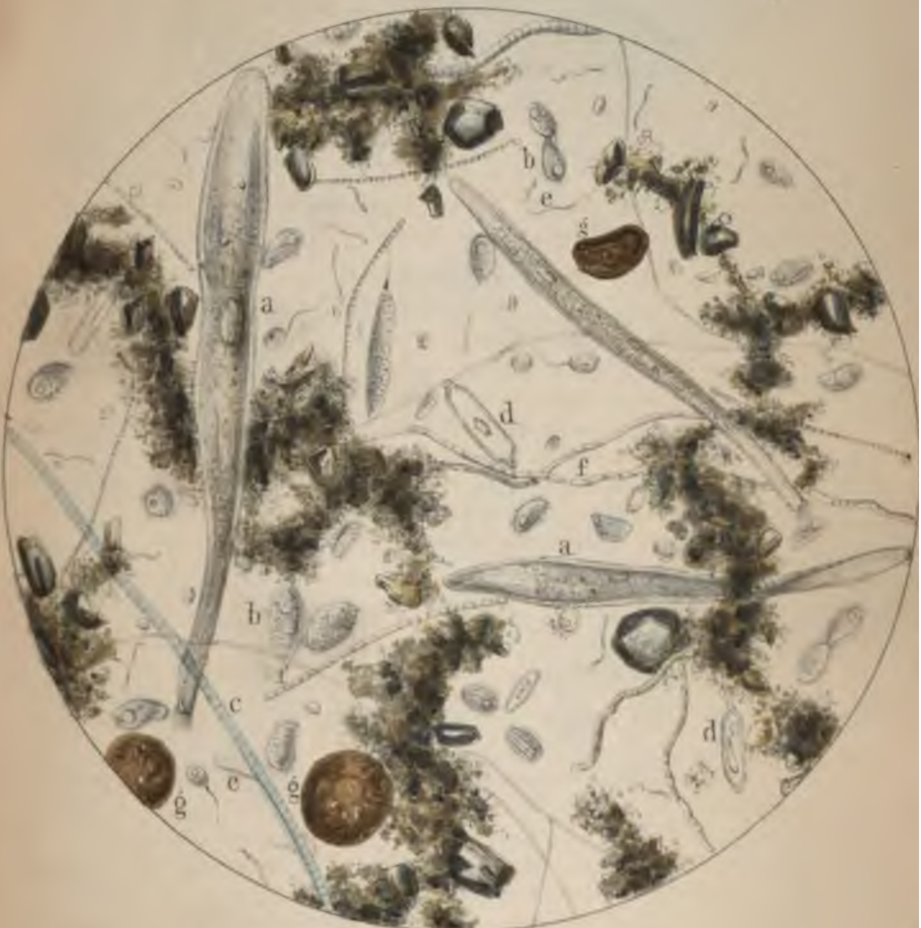
IT was not stated whether cholera existed at Romsey at the time when the two specimens of water were forwarded, the results of the Microscopical Examination of which are given below.

No. 13.—Well water from *Romsey*.—Collected 26th September 1854, by Dr. Waller Lewis.

This water, even after standing for some time, remained somewhat opalescent; it threw down a very considerable brown sediment. This abounded in the threads and filaments of no less than three different fungi, it contained a great many filaments of a slender fungus, numerous brown sporules, single and aggregated, of another fungus, and a few threads of a third species; there were likewise present in it some infusoria, a rotifer, coleps hirtus, paramecia, but especially monads, and the cells of some decaying vegetable tissue. Fig. 13.

No. 14.—From Pump in *Reading Room, Corn Market, Romsey*.—Collected October 1854, by Dr. Waller Lewis.

A wine bottle only of this water was sent up, and yet it deposited as much sediment as would have half filled a small teaspoon; it contained a great many animalculæ, and abounded in diatomaceæ. Amongst the former were several worms, daphnias, oxytrichæ, cuplotes, and numerous

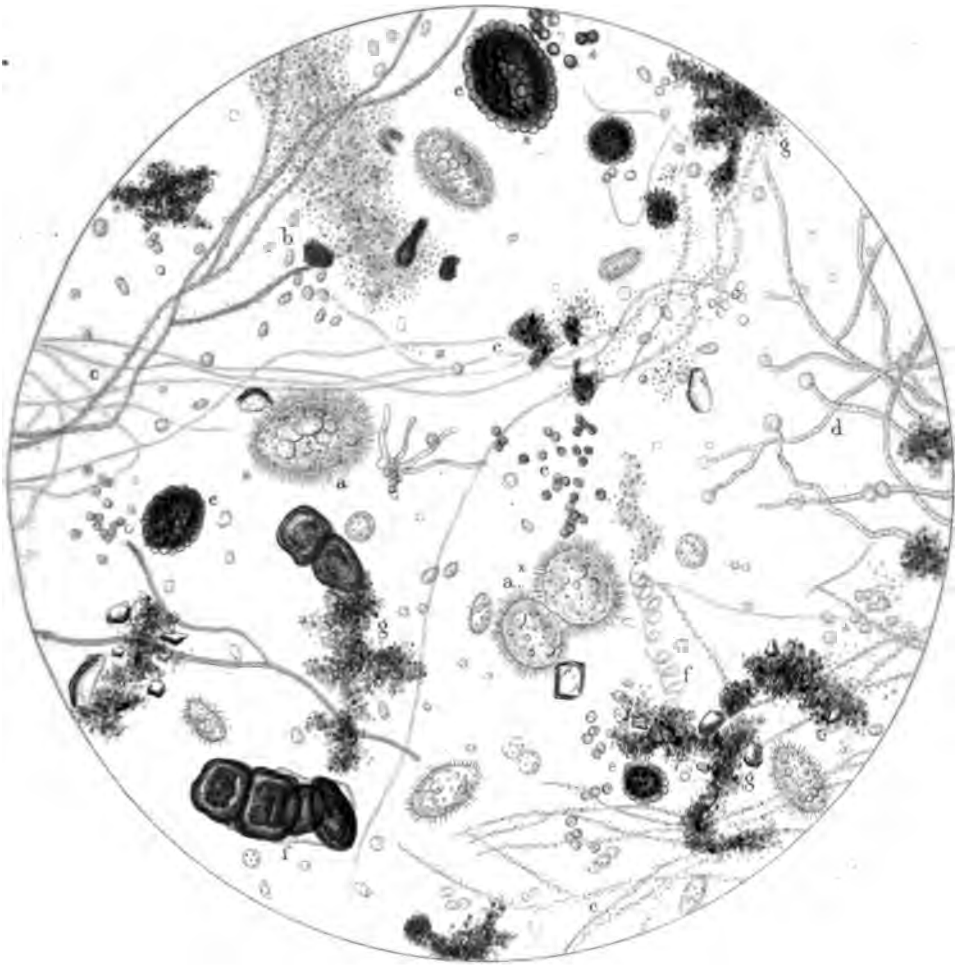


220 diameters

a.	*Spirostomum ambiguum ?*	e.	*Vibriones*
b.	*Paramæcia*	f.	*Fungus &c*
c.	*Oscillatoria*	g.	*Brown corpuscular bodies*
d.	*Frustules of Diatomaceæ*	h.	*Grit & Dirt*

H. Miller del. Tuffen West lith. Dr A. H. Hassall direxit Ford & West i

WELL WATER FROM ROMSEY.



a *Paramecia*
b *Monads*
c *Filaments of a Fungus*
d *Sporules germinating of a Fungus Penicilium glaucum.*
e *Brown Sporules of Fungus & aggregations of the same resembling the so called "Cholera corpuscles" of Dr Swayne*
f *Cells & fragments of spiral vessels &c of decaying vegetable tissue*
g *Sand & Dirt*

a Cypris?
a* Ova of same
b Anguillula fluviatilis
c Oxytricha pellionella
d Euplotes Patella

e Paramæcia
f Coleps hirtus
g Amœba diffluens
h Synedra Ulna
i Melosira arenaria

k Pleurosigma attenuatum
l Diatoma vulgare
m Cocconeis Placentula
n Gomphonema capitatum
o Fragilaria capucina

p Threads of slender Fungus
r Decaying organic matter & Grit

infusoria of the genus coleps; amongst the diatomaceæ were hundreds of frustules of synedra ulna, very large and fine, threads of fragillaria capucina, of meloseira arenaria, and several frustules of diatoma vulgare, cocconeis placentula, pleurosigma atennuatum, gomphonema capitatum, and a few of some species of pinnularia. Fig. 14.

The conclusions to be deduced from the preceding Microscopical Examinations of different Pump and Well Waters, principally obtained from Cholera Districts, are the following:—

That nearly all of the well waters examined were of a very impure description.

That seven of them abounded in animal and vegetable productions belonging to different classes, including entomostraceæ, annelidæ, infusoriæ, diatomaceæ, and fungi, and they also contained dead organic matter of different kinds.

That at least two of the waters were evidently contaminated with sewage matter, which had principally assumed the form of nitrates, viz., Nos. 6 and 7.

That in none of the waters was any production met which could be supposed to exert any influence in giving rise to cholera, although in several of them vibriones were detected. If any peculiar body capable of producing cholera is ever present in water, it would be in well waters that this would be most readily detected, because these waters as a rule contain a much less variety of organic productions, than does river water in general, especially Thames water, in which, from the great number of productions present, any very minute or peculiar body might possibly be overlooked.

That amongst the waters examined were two samples from the Broad Street pump to which Dr. Snow has drawn so much attention, and that in neither of these was any peculiar body or production met with calculated to excite suspicion. The only animalcules seen were two or three of small size, resembling a species of amphileptus, rather many monads, and several of the brown bodies termed ova cases; the animalcules were, however, present in sufficient quantities to show that the water was not in a pure condition.

These results of the examination of merely a few samples of well water are sufficient to show that much which is very wrong exists in the condition of this description of water as procured from ordinary wells, so common indeed is it to meet with impure well water, that it would have been an easy matter to have multiplied the number of specimens to almost any extent. Enough, however, has been done to show that it would be a very proper step to subject all the shallow well waters in use to some general examination, so that those that are contaminated might either be condemned, or the sources of contamination removed. The great source of contamination of well water, as already mentioned, are the cesspools; these done away with, and the wells themselves properly covered over, the waters of many of our shallow wells would be of a high degree of purity, and would to a considerable extent be free from organic matter, provided the soil surrounding these wells was not itself contaminated.

(3.) RESULTS of the MICROSCOPICAL EXAMINATION of WELL, PUMP, and other WATERS from SANDGATE.

The following samples from Sandgate and its vicinity were procured, under the direction of Dr. Milroy, during the prevalence of cholera in that locality.

CHERITON WATER WORKS.

Mr. Bateman's, 1, Beach Cottage.—Collected 6th October 1854, by Dr. Bond.

The sediment deposited from this water was very large, and of a fawn colour; it contained but few infusoria, and scarcely any that were large; one large annelid only was seen, and a few vibriones, one piece of decaying vegetable tissue, and a good number of the yellow branched threads of the production resembling anthophysa.

Residence of Mr. George.—Collected 6th October 1854, by Dr. Bond.

In the House from which this Water was obtained Five Deaths from Cholera occurred.

This water was dull and opalescent, and deposited scarcely any sediment; there were seen in it a very few infusoria only, but rather a large number of vibriones, and masses of the same motionless; there were no diatomaceæ, but it contained a few small fragments of decaying vegetable tissue. The worst characters of this water were its opacity and the number of vibriones present in it.

FOLKSTONE COMPANY.

Residence of Mr. Penreth.—Collected 6th October 1854, by Dr. Bond.

One Death occurred in this House.

This water, on standing, deposited a rather copious sediment, which contained a great number of organic productions, living and dead; amongst the former were detected numerous infusoria, including an annelid, one or two stentors, several rotifers, one coleps, and many animalculæ of the genus amphileptus. Amongst the vegetable productions were seen various diatomaceæ belonging to different genera and species; there were observed frustules of diatoma vulgare, cocconema, gomphonema, synedra, as well as several frustules of coscinodiscus minor, and some of cymbella cuspidata; two species of scenedesmus were the only desmideæ noticed; there was also rather much slender fungus, together with a few vibriones, single and in masses, spiral vessels, and other fragments of decaying vegetable tissue, and portions of the broken shells of Cyclops.

Reservoir at Shorncliff.—Collected 21st September 1854.

The sediment from this water was rather considerable, consisting chiefly of organic matter, together with some grit. It swarmed with paramecia, and contained a few large oxytrichæ, and much of the slender fungus.

FROM WATER OF WELL AT SANDGATE
(on Mr. George's premises)

Magnified 220 diam.

a. *Rotifer.*
b. *Bursaria?*
c. *Paramecium.*
d. *Acineta tuberosa?*
e. *Vorticella.*
f. *Actinophrys Sol.*
k. *Earthy & Organic matter.*
g. *Filament of Conferva.*
h. *Stems of Anthophysa?*
i. *Slender fungus.*

Reservoir at the Castle Hill, Sandgate.—Collected 21st September 1854.

The deposit from this water was large in quantity, and of a brownish colour; in it there were found only a few infusoria, and those for the most part of very small size, and one large oxytricha; there was also a large quantity of the ordinary slender fungus, and much gritty and earthy matter.

Main, Belle Vue, Sandgate.—Collected October 1854.

The sediment deposited from this water was very considerable indeed, and of a brownish yellow colour, due apparently to the presence of iron. It contained some infusoria of small size, but not in large number, including a few of the genus oxytricha and paramecium, with a few spiral vibriones. There were no diatomaceæ or fragments of dead vegetable tissue present, but it contained a good deal of granular and dotted organic debris.

Tap at Belle Vue House.—Collected 6th October 1854, by Dr. Bond.

Four Deaths occurred in this House.

The water in this case threw down a large yellowish brown deposit, having much the same character as that from the water obtained from 1, Beach Cottage. In this there were only a very few small infusoria, including one or two actinophydes, a few threads of the slender fungus so frequently present in water, as well as some of the yellow branched fungus looking stems, resembling anthophysa; no diatomaciæ were seen.

Water from Tap, New Inn.—Collected 20th September 1854.

The sediment deposited from this water was not very large; there were discovered in it several paramecia, one large oxytricha, and a good deal of the slender fungus so frequently referred to.

Well Water.

Residence of Mr. George.—Collected October 1854.

The residue from this water was considerable, of a brown colour, and it contained a good deal of organic debris, and many living infusoria, especially of the genera amphileptus and amœba, together with a few green sporules resembling those of a fungus, and vibriones; there was also a small quantity of the thallus of the ordinary slender fungus.

Mr. George's Residence.—Collected October 1854.

This water let fall much organic residue, in which were discovered a rotifer, a large number of actinophrydes, a few paramecia, and other infusoria, as acineta tuberosa, vorticellæ, bursariæ, some of the pale granular spherical bodies which sometimes occur in Thames water, together with much slender fungus in threads, and a large quantity of the yellow branched stems resembling anthophysa. Fig. 15.

Residence of Mr. Marsh.—Collected 6th October 1854, by Dr. Bond.

In this House One Person died and Four others were choleraically ill.

This water deposited a very minute quantity of sediment only; when examined with the microscope there were seen several infusoria, principally oxytrichæ, a great number of filaments of the ordinary slender fungus, as also a second species of fungus belonging to the genus dactylium, together with a few fragments of decaying vegetable tissue.

House opposite Rea's Cottage.—Collected October 1854, by Dr. Bond.

There were Five Deaths in this House.

The residue of this water was rather considerable in amount, and of a brownish colour; it contained the usual annelid anguillula fluviatilis, two different species of paramecium, several oxytrichæ, a good many actinophrydes and vorticellæ, with numerous animalculæ belonging to the genera amphileptus, lagenella, and amœba, also many monads. There was likewise much of the slender fungus, as well as two other species of fungus, together with a good deal of the yellow branched stems resembling anthophysa, and granular organic matter. Fig. 16.

Pump at New Inn.—Collected 20th September 1854.

This water deposited scarcely any sediment; there were seen a few infusoria of the genus oxytricha, and a few monads, with several threads of a species of conferva resembling those of a monormia.

Stream of Mr. Bligh.—Collected 21st September 1854.

A very large residue, consisting principally of organic matter, and containing fragments of vegetable tissue, was deposited from this specimen. The number of infusoria was comparatively not large, but several oxytrichæ, belonging to two different species, were observed, as well as other small infusoria. There were no diatomaceæ present.

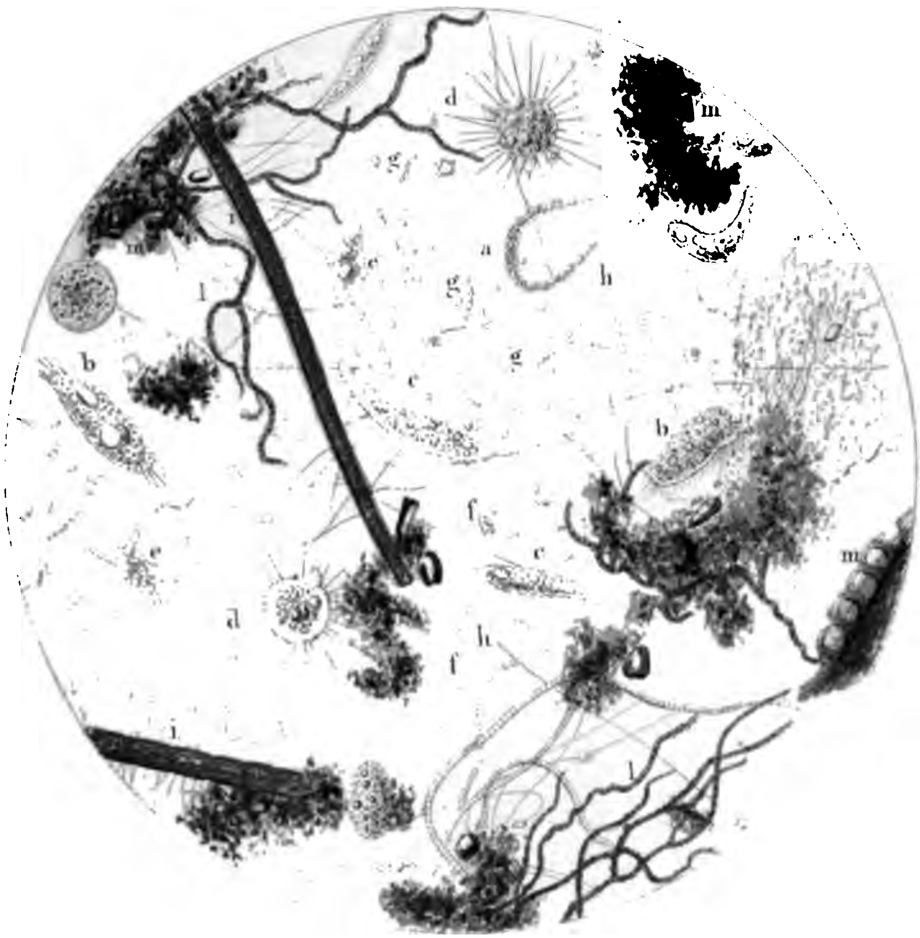
From the above Microscopical Examinations it appears,—

1st. That the whole fourteen samples of water examined were contaminated with organic matter, dead and living, the quantity in the majority of the samples being very considerable. The only water in a state approaching even to purity, was that from the pump at New Inn.

2d. That in none of the waters were any peculiar organic productions detected, which could be supposed to exert any direct influence in occasioning cholera.

FROM WATER OF WELL AT SANDGATE.

(from House opposite Rea's Cottages)



a. *Anguillula fluviatilis*
b. *Oxytricha*
c. *Amphileptus*
d. *Actinophrys Sol.*
e. *Amoeba diffluens*
f. *Monads.*
g. *Vibriones.*
h. *Threads of slender Fungus*
i. *Threads of Brown Fungus.*
k. *Filaments of another Fungus.*
l. *Stems resembling Anthophysa.*
m. *Dead and decaying organic matter, Grit, and fragments of Vegetable Tiss*

Lambeth Company.

26, *Waterloo Road.*—Collected 16th December 1854, by Mr. Mears.

The quantity of sediment from this water was but small, and consisted chiefly of organic matter. In it there were found one eel-like annelid and a few small infusoria, principally of the genus monas; there were a good many diatomaceæ, including several frustules of synedra ulna, two or three of a second species of synedra, a few frustules of gomphonema, and threads of meloseira varians, together with five or six green rolling sporules, and a little of the slender fungus. Amongst the dead organic matter were a great number of the brown ova cases, several fragments of decaying vegetable tissue, and two broken shells of Cyclops.

126, *Waterloo Road.*—Collected 16th December 1854, by Mr. Mears.

The sediment in this instance was less than in the previous sample, but its constituents were nearly similar. Amongst the infusoria were two annelidæ, a few small euglenæ, and many monads, there were several frustules of synedra ulna and other diatomaceæ, a large number of the brown ova cases, some of the slender fungus, and many fragments of decaying vegetable tissue.

West Middlesex Company.

77, *Upper Berkeley Street.*—Collected 28th September 1854, by Dr. Greenhow.

Eight or nine small infusoria were seen in this water after subsidence, as well as nine or ten entomostraceæ, Cyclops quadricornis in a peculiar condition of growth. The sediment was rather considerable, and in it the following organic and other productions were seen:—three small worms, anguillula fluviatilis, five or six loricated infusoria, a species of euchlanidota, several actinophydes, oxytricha pellionella, vorticellæ, many small paramecia, a few animalcules of the genus coleps and lagenella, five or six of the genus amphileptus, and three or four polyarthræ. Amongst the desmideæ were four or five fronds of scenedesmus quadricauda and sc. acutus, and pediastrum boryanum; amongst the diatomaceæ were many frustules of cyclotella operculata, several of Nitzschia sigma, three or four groups of frustules of synedra minutissima, frustules of meloseira varians, amphora ovalis, and of two or three different naviculæ. Amongst the dead organic matter were a great many fragments of shells of entomostraceæ, many of the exuvial masses, and other debris, intermixed with which were the green branched threads of some conferva, and the usual fungus with slender threads. In addition to the brown bottle-shaped sporules, lagenella, were other brown sporules, round and oval. Fig. 17.

(4.) **Report showing the Results of the Microscopical Examination of different samples of Water obtained from the Service Pipes of several of The Metropolitan Water Companies.**

Inasmuch as the condition of water taken from cisterns is, to some extent, dependent upon the cisterns themselves, whether they are covered or not, and whether they are regularly cleaned out, so as not to allow of accumulation, it might be considered that it was not proper to judge of the quality of the water supplied by any Company by its state as taken from cisterns. This objection, no doubt, holds good to a certain extent, but not so much as might be supposed. In order, however, to meet this objection, and to ascertain the actual condition of the waters of the several Companies, specimens were obtained from the service pipes, that is, the several waters were procured precisely as supplied for use. The results of the Microscopical Examination of these waters were as follows:—

Grand Junction Company.

3, *South Row, Golden Square.*—Collected 15th December 1854, by Mr. H. Miller.

After standing the usual time this water threw down rather much sediment; there were present in it a good many monads and other infusoria, several euglenæ and oxytrichæ, together with large green moving sporules. The diatomaceæ abounded, and included several genera and species, amongst which the following were conspicuous— frustules of cymatopleura solea, synedra ulna, and a few of two other species of synedra, many frustules of diatoma vulgare, navicula amphisbœna, and other naviculæ, a good number of frustules of pleurosigma hippocampus, and very many of coscinodiscus eccentricus, with a few filaments of meloseira varians and fragillaria capucina. Amongst the dead organic matter were some of the brown ova cases, many spiculæ of the fresh water sponge, much organic debris, a fragment of firwood, and a good deal of decaying vegetable tissue.

13, *Marshall Street.*—Collected 15th December 1854, by Mr. H. Miller.

The sediment from this sample was about equal in quantity to that from the previous water, and consisted principally of dead and living organic matter; it also resembled, in the organic productions of which it was constituted, the water from South Row. Amongst the infusoria, however, there were noticed, in addition to those mentioned in the previous sample, an acarus-like entomostracan with a red eye, and one or two large paramecia, P. aurelia. The diatomaceæ were equally numerous, and belonged to the same genera and species; frustules of coscinodiscus eccentricus were likewise observed, as well as a few of cyclotella operculata; there was a good deal of dead organic matter, many fragments of decaying vegetable tissue, and spiculæ of the fresh water sponge, intermixed with and growing amongst which was a considerable quantity of the usual slender fungus.

FROM WATER OF CHELSEA COMP^{Y}. PL. 13.

(from Service pipe.)

a *Anguillula fluviatilis*
b *Paramaecia. 2 species*
c *Vorticella*
d *Coleps hirtus*
e *Euglena*
f *Monads*
g *Scenedesmus quadricauda*
h *Cyclotella operculata*
i *Melosira varians*
k *Synedra minutissima*
l *Navicula amphisbaena*
m *Green motionless Sporules*
n *Slender fungus*
o *Germinating fungus*
p *Dead organic matter & Grit*

77, *Upper Berkley Street.*—Collected 12th December, 1854, by Dr. Headlam Greenhow.

This water was not perfectly bright and clear, but possessed a slight degree of opalescence. After subsidence there were found, in the fluid part, a great many monads and other small infusoria. The sediment deposited from it was considerable, and consisted mainly of organic matter, dead and living. Amongst the animalculæ were numerous vorticellæ, V. convallaria, sometimes in groups, a few euglenæ, panophrys chrysalis, paramecia, oxytrichæ, myriads of monads, and a great many vibriones and masses of same. Amongst the diatomaceæ were a very few frustules of Nitzschia sigma, and some of synedra minutissima, cyclotella operculata, and cocconeis placentula; while amongst the dead organic matter were numerous fragments of decaying vegetable tissue, hairs of animals, scales of a moth, and a great many spiculæ of the fresh water sponge; growing from and intermixed with the dead organic matter were three different species of fungus; in addition to which there were many thousands of the brown ova cases, single and in masses.

Chelsea Company.

27, *Lawrence Street.*—Collected 13th September, 1854, by Dr. Greenhow and Dr. Hassall.

Three or four minute infusoria only were seen in this water after subsidence, and the sediment which fell from it was extremely small; but in it the following organic and other productions were detected: three small river annelidæ, anguillula fluviatilis, two vorticellæ, two oxytrichæ, several paramecia, three or four of a green colour, a good number of coleps hirtus, and a few euglenæ. The principal desmideæ belonged to the genus scenedesmus, of which eight or nine fronds were seen. The diatomaceæ were plentiful, and consisted of frustules of cyclotella operculata, several, synedra minutissima, navicula amphisbœna, and meloseira varians; in addition to these, were green sporules, fixed and moving, the two ordinary species of fungus, a tuft of penicilium glaucum, and a little yellow debris. Fig. 18.

27, *Turner Street.*—Collected 13th September, 1854, by Dr. Greenhow.

But one rather large green animalcula seen in this water after subsidence. There was only a small quantity of deposit, which consisted principally of the yellow fungus, but amongst which were also noticed a great many infusoria of the genus coleps, several actinophydes, oxytrichæ, and paramecia, as well as rather many frustules of cyclotella, and a few fronds of pidiastrum.

Southwark and Vauxhall Company.

From *St. Thomas's Hospital.*—Collected October 1854, by Mr. Walker.

This water, after having stood for several hours, was still dull and opalescent, while the sediment deposited was very considerable, and in it the following organic productions were specially noticed:—several acari-like animalculæ of the class tardigrada, commonly called water-bears, seven or eight stentors, stentor mulleri, numerous rotifers, many large paramecia, bursariæ, vorticellæ, oxytricha pellionella, amphileptus, and several animalcules of the genus coleps. Amongst the desmideæ were a great many of the lunar sceuedesmus, and a few pediastra; and amongst the diatomaceæ, which were very abundant, were very many frustules of the usual cyclotella and Nitzschia sigma, occasional threads of meloseira varians, and several frustules of synedra minutissima, navicula amphisbœna, cymatopleura solea, and of Nitzchia dubia. Amongst the dead organic matter were a great many of the pellet-like exuvial masses of the entomostraceæ, and a few fragments of muscular fibre derived doubtless from the fæces, and fragments of dead vegetable tissue; intermixed with these and other matters was a large quantity of the slender fungus, and some of the yellow kind also. Fig. 19.

12, *Neptune Street, Spring Place, Wandsworth Road. From Main.*—29th September 1854. Sent to General Board of Health by Dr. Ayres.

This water smelt very offensively of sulphuretted hydrogen, and on standing at rest for some time, sufficient sediment collected at the bottom of the bottle nearly to fill two teaspoons; this was of a blackish colour, and abounded in many different kinds of organic productions. It contained all the usual elements of River Thames and Southwark and Vauxhall Company's water, worms, shells of entomostraceæ, dozens of spiculæ of sponge, eggs of zoophytes, &c. &c.; indeed, a volume might be filled with a description of the organic productions present in this water.

Main in Crescent Road, Park Road.—Collected 18th September 1854, by Mr. James Frost.

The water in this case was nearly black, and threw down a large quantity of black sediment, the colour was due partly to the presence of iron, derived no doubt from the mains. It abounded in organic productions, most of them being dead when the water was examined. Many dead entomostraceæ and rotiferæ were discovered, a great number of diatomaceæ, especially the usual species, also vibriones, and numerous spiculæ of the fresh water sponge.

Main in Crescent Road, Park Road.—Collected September 1854, by Mr. Samuel Frost.

This water was very dirty and opalescent, from the presence of a very large quantity of organic matter in solution, the smell was also

FROM WATER OF SOUTHWARK & VAUXHALL COMPANY Pl

(from service pipe)

Magn.d 220 diam.s

a. *Brachionus*
b. *Stentor Mulleri*
c. *Bursaria*
d. *Paramecium aurelia*
e. ——— *sp.*
f. *Oxytricha*
g. *Verticella convallaria*
h. *Coleps hirtus*
i. *Pediastrum Boryanum*
k. *Scenedesmus acutus*
l. *Melosira varians*
m. *Cyclotella operculata*
n. *Navicula amphisbæna*
o. *Cymatopleura Solea*
p. *Nitzschia Sigmoidea*
r. *Fragments of muscular fibre*
s. *Starch corpuscles of Wheat*
t. *Ditto coloured by Iodine*
u. *Husk of Wheat*
w. *Hairs of Wheat*
x. *Earthy & Organic Matter*

exceedingly offensive. The residue, which was very considerable in amount, consisted chiefly of organic matter, dead and living, and in it there were found a great number of infusoria, including dozens of rotifers, and many other rotiferæ, of the genus anuraea, as well as several of the large twisted paramecia; amongst the diatomaceæ were noticed especially Nitzschia sigma and cyclotella operculata; amongst the desmideæ there were a few pediastra; a good many spiculæ of the fresh water sponge were likewise present.

Main in Crescent Road, Park Road.—Collected September 1854, by Dr. Hassall and Mr. Frost.

This specimen was obtained from the same locality as the two previous waters. After standing at rest for some time, the water still remained thick and opaque, and threw down a very copious sediment. In the fluid part there were discovered a great many euglenæ, frustules of cyclotella operculata, and a large number of sporules and beaded threads of a species of fungus. The sediment swarmed with infusoria of all kinds, including entomostraceæ, a large number of the eel-like annelidæ, as well as one other annelid, resembling the blood-worm, also animalculæ of the following genera, brachionus, oxytricha, stentor, actinophrys, euglena, and vorticella, the latter being very abundant. It contained also a very large quantity of the usual slender fungus in masses, visible to the naked eye, the yellow fungus, together with many of the exuvial masses derived from the entomostraceæ, numerous spicula of the fresh water sponge, and dead and decaying vegetable tissue.

New River Company.

3, Broad Street, Golden Square.—Collected 14th December 1854, by Mr. H. Miller.

There were present, in the fluid part of this water after subsidence, a few monads and other minute infusoria. In the sediment, which was small, there were monads and other minute actively moving animalculæ, as well as infusoria of other kinds, but their number altogether was not large; two rotifers, two or three actinophrydes, a few euglenæ, as well as green moving sporules, some large flat pale brown stationary sporules, as also some of another brown sporular body were seen; these latter were of a somewhat lenticular form, being convex on one side, and concave on the opposite side, with a large circular aperture. The diatomaceæ were very abundant, there being hundreds of frustules of synedra, of two or three different species, several frustules of navicula binodis, two of gomphonema, two or three of cymbella, one of a species of cocconema, many of pleurosigma hippocampus, and several threads of fragillaria capucina; there were also a few short filaments of oscillatoria, and two or three fragments of decaying vegetable tissue.

9, *Hopkins Street, Golden Square.*—Collected 14th December 1854, by Mr. H. Miller.

In this specimen the sediment was rather small, and like the previous sample, the number of infusoria was not great in proportion; they consisted of one river annelid, one actinophrys, and an oxytricha. It contained, however, a large number of vegetable productions, especially diatomaceæ, of which the chief were the different species of synedra noticed in the sample of New River water from Broad Street, including many frustules of synedra ulna; in addition to the various species of synedra, there were a great many frustules of pleurosigma hippocampus, and of a second species of pleurosigma, with nonstriated frustules, one nitzchia sigmoidea, a few frustules of the genera navicula, cocconema, and gomphonema, and several threads of fragillaria capucina. The only desmideæ seen were two or three fronds of scenedesmus quadricauda, but there were a few threads of two or three species of conferva, belonging to the genera zygnema and vesiculifera, some green moving sporules were likewise observed, as well as a great many of the brown ova cases, and a few small fragments of decaying vegetable tissue.

East London Company.

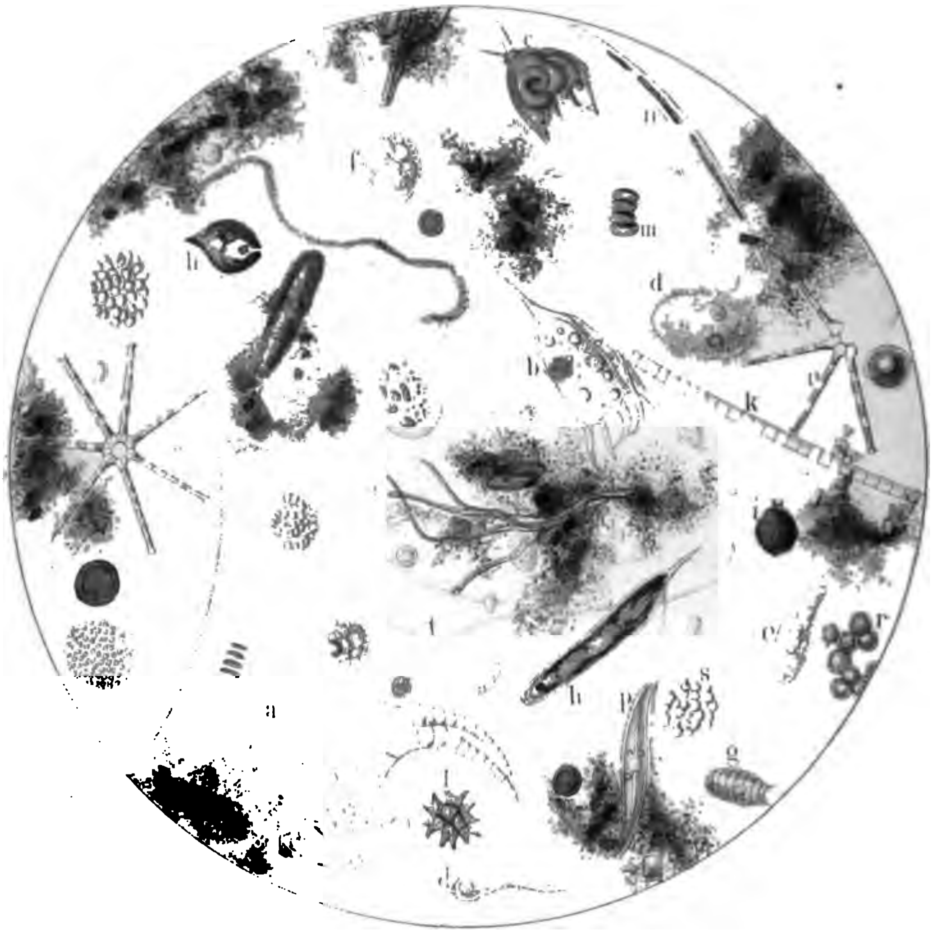
4, *Dock Street.*—Collected 14th December 1854, by Mr. Wildbore.

The quantity of sediment deposited from this water was rather considerable, and consisted principally of organic matter intermixed with numerous gritty particles; the number of living organic productions contained in it was large, and included several species and genera of infusoria, and the same of desmideæ and diatomaceæ. The infusoria embraced the ordinary genera, as monas, coleps, paramecium, oxytricha, and polyarthra, together with one or two annelidæ. Amongst the desmideæ noticed were fronds of desmidium hexaceros, and amongst the diatomaceæ frustules and threads of meloseira varians and fragellaria capucina, frustules of pleurosigma, cocconema, and different species of synedra. In addition to these productions there were the usual species of fungi, that with slender threads and the yellow branched stalks (the quantity of this last being considerable), pieces of vegetable tissue, and fragments of granular organic debris.

1, *Back Church Lane, Whitechapel.*—Collected 13th December 1854, by Mr. Wildbore.

The sediment deposited from this sample was rather considerable, and about equal to that from the previous water. The same productions were likewise met with, but in addition a few others were observed, including two or three rotiferæ, frustules of diatoma vulgare, synedra ulna, and cymbella cuspidata, together with threads of meloseira varians and fragillaria capucina, and a few of the brown festooned sporules. The quantity of dead and decaying organic matter which was infested with the slender fungus was considerable.

FROM WATER OF HAMPSTEAD COMPANY. Pl. 20.
(from service pipe)



a. [illegible]
b. [illegible]
c. [illegible]
d. [illegible]
e. [illegible]
f. Vorticella [illegible]
g. Coleps hirtus
h. Euglena
i. Lagenella
k. Oscillatoria
l. Pediastrum Napoleonis
m. Scenedesmus quadricauda
n. Closterium acerosum
o. Asterionella formosa
p. Pleurosigma acuminatum
r. Green motionless sporules
s. Colourless sporules of Fungus
t. Slender fungus

Hampstead Company.

47, *Arlington Street, Hampstead Road.*—Collected 16th September 1854, by Mr. Botteler.

This water was somewhat disagreeable to the taste and smell, and was rather turbid; the sediment deposited was considerable, and contained numerous living organic productions, amongst which were noticed several dozen animalculæ of a species of brachionus, seven or eight vorticellæ, several of the genus amphileptus, two or three oxytrichæ, several of the genera coleps and lagenella, some of the ordinary euglenæ, rather many small paramecia, four or five of a species of euglena resembling E. longicauda, and the same number of pandorina morum. Amongst the desmideæ were rather many pediastra and scenedesmus, and two closteria. Amongst the diatomaceæ were several asterionellas, and one or two pleurosigmas; lastly, there were rather many of the brown peculiar bodies which occurred so abundantly in the water procured from the Golden Square district, round and green sporules, rather large, and groups of bottle green sporules. The sediment which subsided not only contained the productions above enumerated, as well as many others, but was composed in great part of earthy matter, and organic debris, including many fragments of the shells of entomostraceæ, and the exuviæ of the same.

47, *Arlington Street, Hampstead Road.*—Collected 20th September 1854, by Mr. Botteler.

A second specimen of this water presented characters nearly identical with the above. The water itself, after complete subsidence, was rather opalescent, and there were seen in it, with the microscope, a few brown and green sporules, a few desmideæ of the genus scenedesmus, and one asterionella. The residue which subsided was considerable, and of a fawn colour, and under the microscope it presented a granular texture; the number of infusoria seen was not great, but a shell Bosmina longirostris, a brachionus, one eel-like worm, a species of the genus euglena, twisted like the letter S, and a few lagenellæ, L. euchlora; the number of pedastria seen was very great, and included the following species, P. elegans, P. hexactis, P. pertusum, and P. heptactis; clostereum acerosum, scenedesmus quadricauda, and S. lunaris were also observed, and there were a few asterionellas, frustules of pleurosigma acuminatum, as well as some brown and green sporules. Fig. 20.

Kent Company.

From *Filter.*—Collected 30th September 1854, by Dr. Hassall accompanied by Engineer of Works.

Rather many monads were present in this water after complete subsidence. There was scarcely a trace of visible sediment, but

nevertheless there was sufficient to furnish the following results. There were noticed two river annelids, several of a loricated animalcula allied to rotifer, oxytrichæ, of three different species, several, a few animalcula of the genera paramecium, coleps, and euglena; one brown motionless sporule, a pleurosigma, and a navicula, a dotted duct, and some of the slender fungus.

From *Service Pipe.*—Collected 30th September 1854, by Dr. Hassall accompanied by Engineer of Works.

Four or five minute infusoria only were seen in this water after subsidence. There was scarcely a particle of sediment visible to the naked eye, but yet there were discovered, with the microscope, more than a dozen of the loricated rotifer-like animalcula, nine or ten very small eel-like annelids, anguillula fluviatilis, three animalcules of the genus polyarthra, two euglenæ, several monads, two or three frustules of diatomaceæ, including meloseira varians, and a little of the slender fungus. Fig. 21.

The following *conclusions* may be deduced from the preceding examinations of specimens of Water procured from the SERVICE PIPES of the different Metropolitan Water Companies:—

1st. That the samples of water procured from the service pipes of the *Southwark and Vauxhall Company* abounded, like those from the cisterns supplied by the same Company, in organic matter, living and dead, animal and vegetable, including entomostraceæ, annelidæ, infusoria, desmideæ, diatomaceæ, fungi, fragments of decaying and dead vegetable tissue, as the hairs and husk of wheat and other vegetable substances, starchy matter, and in some cases even fragments of altered muscular fibre, derived from the fæcal matter poured into the river from the sewers.

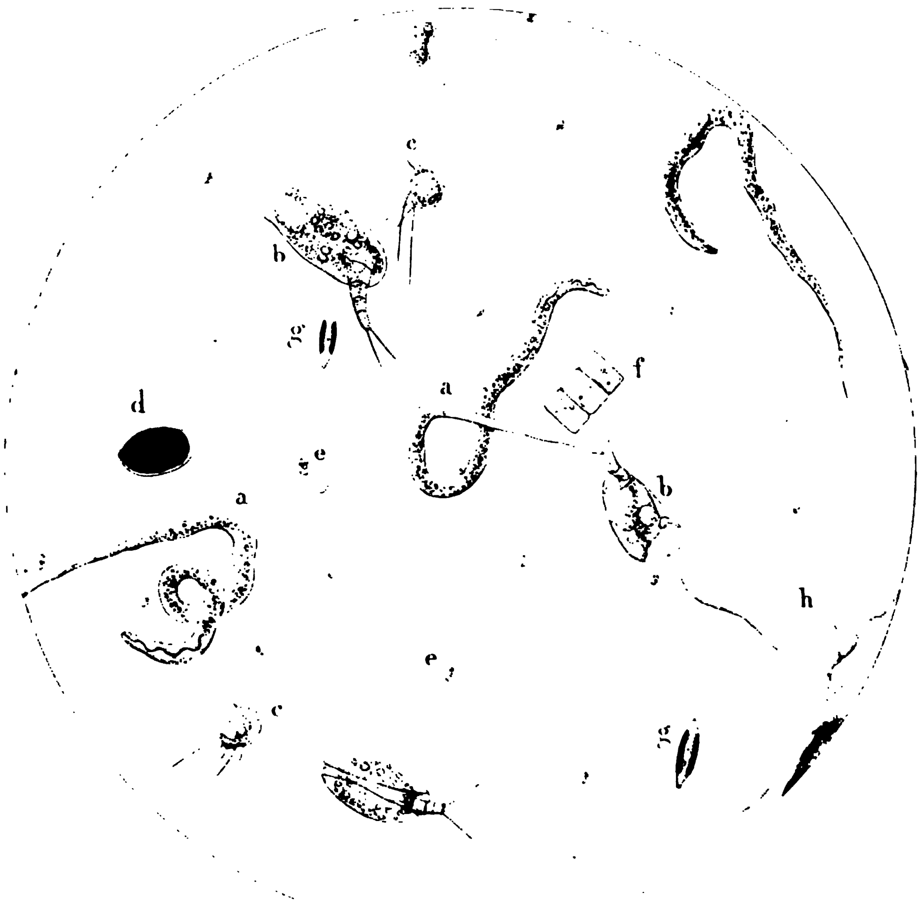
2d. That many of the same species of productions were detected in the water of the *Chelsea Company* as were present in that of the Southwark and Vauxhall Company, although in greatly diminished numbers. This difference is attributable, as already pointed out, to the circumstance that a tolerably efficient method of filtration of this water is adopted previous to its distribution.

It has been declared that the water supplied by the Southwark and Vauxhall Company is filtered previous to distribution. From the results derived from its examination we can scarcely believe that it undergoes any process of filtration whatever before delivery. If it be filtered, it is very certain that the method adopted is all but useless, for between it and the water of the Thames, as taken from the river at the spot at which the Southwark and Vauxhall Company obtains its supplies, there is only that amount of difference which would arise from mere subsidence.

The organic productions contained in the water of the Southwark and Vauxhall Company as supplied correspond exactly with those of Thames water itself, and their number is nearly as great; indeed, so abundant and peculiar are the productions contained in Thames water, near the bridges, that by the microscope alone this water and

FROM WATER OF KENT COMP^{Y}

(from Service pipe.)



a *Anguillula fluviatilis* | c *Polyarthra* | e *Monads*
b *Rotifera* | d *Euglena* | f *Melosira varians*
 | g *Pinnularia* | h *Threads of slender fungus*

that of the Companies which take their supply from the river Thames near the metropolis may be readily and most certainly distinguished. We have already referred to the fact of the occurrence in Thames water near the bridges, as well as in the waters of those Companies which obtain their supply from the same part of the Thames, of certain species of diatomaceæ, found only in brackish water, a remarkable and important fact which, independent of other considerations, is sufficient to show that this water ought never to have been employed for the supply of the metropolis.

3d. That the quantity of organic matter and number of living organic productions contained in the water of the *West Middlesex Company* was very considerable, so much so, indeed, as to make it exceedingly doubtful whether the water which it supplies is filtered before delivery or not, and, if filtered, it is evident that the process is far from effectual.

4th. That the water of the *Hampstead Company* as supplied, likewise abounded in a great variety of organic productions, several of the species being different from those contained in the River Thames waters. It is, therefore, very doubtful whether this water is filtered. Some of the samples examined have been distinctly coloured, and have even emitted a somewhat offensive smell.

5th. That the waters of the *New River* and *Grand Junction Companies*, the one taking its supply from the New River, the River Lea, &c., the other from the Thames at Brentford, both contain a considerable amount of organic matter, and many forms of animal and vegetable life. The water of the Grand Junction Company was distinguished especially by the large number of asterionellas which it contained, the same diatoma was likewise present in the water of the Hampstead Company, part of the supplies of which are said to be sometimes derived from either the Grand Junction or West Middlesex Company, we believe from the former.

The New River Company, as already stated, does not filter the water which it supplies, and the condition of the water of the Grand Junction Company renders it probable that this also is the case with respect to it.

6th. That the amount of organic matter and the number of organic productions was very much less in the waters supplied by the *Lambeth*, *East London*, and the *Kent Companies*. This is explained by the circumstance that these three Companies now supply filtered water. Living infusoria and other organic productions were, however, present in every sample of the water of the above three Companies subjected to examination, sufficient clearly to establish the fact that these waters were not of that degree of purity which is so desirable. The waters supplied by these three Companies are all river waters, and as such they are exposed to numerous sources of contamination.

(5.) Results of the Microscopical Examination of Water stored in Cisterns, Butts, and Tubs, with Remarks on the State of those Receptacles, and their influence on the Purity of the Water.

There is great variety in the kind and size of the receptacles used for the storeage of water. In the larger houses the water is, of course, received into cisterns, which are either made of lead or slate. To the use of lead for cisterns there are certain objections, into which it is not necessary to enter here. One of the evils attending the use of cisterns is the position in which they are too often placed; sometimes they are situated so awkwardly that they can be reached only with great difficulty, thus offering a considerable obstacle to their being regularly cleaned; in some cases they are placed immediately over the water-closet, so that the water imbibes the emanations which proceed from it. Another evil attending the use of cisterns is that they are often out of condition or repair; very frequently the ball-tap will not act, or is altogether removed, a great waste of water, with inundation of the premises being the consequences; what is of still more importance, the lid of the cistern is often taken away, or sometimes it is not provided with a lid at all, the water is thus exposed to air and light, and the generation and development of animalcula and other organic productions greatly promoted: in other cases the lids are fastened down, so that it is impossible to clean out the cisterns at all, we have seen several instances of this kind, and this where a whole court is supplied by the same tank. Examples without end might be cited of cisterns in all the conditions above described, but the particulars referred to are so well known as to render this unnecessary.

In the houses and cottages of the middling and poorer classes the water is, for the most part, stored in butts, tubs, and pans; these commonly have no lids, and they are unprovided with waste pipes, so that it is not only a matter of difficulty to clean them, but the water is very apt to flow over at the top, and saturate the soil around the house; the position of many of the butts and tubs is also often as objectionable as that of the cisterns. Again, in many cases the size of these receptacles is so small that they do not afford anything like a proper supply of water.

In a great many houses the water is not laid on at all, consequently there is no provision for the storeage of water, but the daily supply is procured out of the house, and is kept in any jugs, dishes, or pans which the people may happen to possess, and which are usually placed in the single room which serves as kitchen, sitting-room, and bedroom.

Having thus briefly referred to some of the objections attached to the different kinds of vessels in which the water is stored, we will now proceed to notice the character and quality of the water contained in them.

In the report on water from cholera houses, we have already given the results of the microscopical examination of a great number of samples obtained from cisterns. The general results of those

examinations went to show that those waters were, for the most part, largely contaminated with organic matter, dead and living. I shall, therefore, now only state the results of a few additional examinations; and before doing this, I shall proceed to notice certain general facts, which have fallen under my own observation, with reference to the condition of water stored in cisterns.

A very great evil connected with cisterns is that the organic matter contained in the water supplied to them does not find a ready egress, but subsiding from day to day, goes on accumulating at the bottom of the cistern; this is owing to the tap not being inserted into the bottom of the cistern, but some little distance up the side; this liability to accumulation shows the extreme necessity that exists for the frequent cleansing of cisterns; there is, in this respect, a most lamentable neglect on the part of occupiers of even superior houses; it is no uncommon thing for these receptacles not to be cleaned out for months, or even years. The consequence of this accumulation is, that the water present in cisterns, from faults of construction and the neglect of cleansing, usually contains a much larger amount of organic matter than that poured into them from time to time.

Another bad effect of the storeage of water in cisterns is, that when the lids are off, which is so frequently the case, the organic matter contained in the water is placed under the conditions most favourable to its development, and this development is not confined to animalculæ and other invisible forms of infusorial life, but includes a large number of living animal and vegetable productions, but too plainly visible to the unaided sight, as the fresh water shrimp, entomostraceæ of various genera and species, hydræ and other zoophytes, different species of mollusca, and conchifera, blood worms, and several other annelidæ; while different species of confervæ and diatomaceæ are often seen growing on the sides of the cisterns, and may often be collected in handfuls. We have seen dozens of cisterns half filled with green conferva and other vegetable and animal productions. Some of the conferveæ and diatomaceæ being attached by roots, and the hydræ and molluscæ, which hold on to these, seldom escape with the water from the cistern; this is also the case with the red worm and the other annelidæ, but for a different reason, since most of these are imbedded in the sediment at the bottom of the butt; nevertheless, they do sometimes escape. The entomostraceæ, commonly known by the name of water fleas, moving freely and actively about the whole water, pass out readily through the tap, and may frequently be seen in dozens, especially in the warm weather of summer, in every jug of the water drawn. Now the entomostraceæ are carniverous, and their appearance in water implies the presence of other creatures, more minute than themselves, upon which they prey. Sometimes large dark spongy looking masses are to be seen in the water of cisterns, floating on the surface; these consist of the polypodoms of certain species of fresh water zoophytes, entangled amongst which are usually hydræ, annelidæ, and a great variety of other organic productions. I forwarded the polypodoms of two zoophytes met with in a cistern to Professor Allman, of Dublin, and he identified one as paludicella Ehrenbergii, and the other was

almost to a certainty plumatella fruticosa. A bottle, containing a large mass of these zoophytes, was brought to me by Mr. Walsh, it was taken from a cistern; while a pickle-jar full of the same was left at the General Board of Health by Dr. Paris; these zoophytes were observed to make their appearance suddenly in the cisterns, and therefore in all probability were not developed in them. On mentioning the sudden appearance of these masses in cisterns to the engineer of the Kent Water Company, he informed me that they were frequently developed to an enormous extent in the iron mains, and this under great pressure, and notwithstanding that light is totally excluded; their sudden presence, therefore, in cisterns is, in most cases, probably owing to the dislodgement of some large mass from the main, and which, becoming broken up, is discharged simultaneously into a number of different cisterns.

Although a great deal of ignorance is too often met with on the subject of water, yet this is not always the case, and many persons are fully alive to the importance of obtaining pure water, are tolerable good judges of its quality, and do their utmost to obtain it in as pure a state as possible by attention to the condition of the cisterns, &c. We have already referred to the practice which prevails extensively in the districts supplied by the Southwark and Vauxhall Company, of tying over the service pipes pieces of muslin, flannel, and even old stockings, for the purpose of intercepting some of the impurities contained in the water; this practice is still more commonly adopted with the tap of the cistern, the quantity of dirt and organic matter obtained in this way in a short time is often perfectly surprising, and clearly shows that the water supplied by this Company cannot possibly be filtered.

The condition of the water, as contained in any cistern or other receiver which is uncovered and exposed to air and light, may be judged of to some extent by its appearance as presented to the eye alone. We have constantly observed that if the water supplied to the cistern itself is comparatively pure, it continued so for some time as contained in the cistern; but if, on the contrary, it was impure, it speedily became still more so after being received into the cistern. In this way the water of the Southwark and Vauxhall Company contained in cisterns could almost invariably be distinguished by the eye alone from that of the Lambeth Company.

So long as cisterns continue to be used, and it is to be hoped that they will not be employed very much longer, it is important that the water should be supplied daily, instead of, as it is in too many cases at present, every second day, or three times a week; for the mere motion and agitation attending its fall into the cistern has a great effect upon its purity, probably owing to some of the dead organic matter becoming broken up and oxydized.

In the preceding brief observations sufficient has been advanced to show that many serious evils are associated with the use of cisterns and other receptacles for the storeage of water. These evils can only be effectually obviated by their abandonment, and by the adoption of the constant, in place of the intermittent, method of supply.

Results of the Microscopical Examination of Six additional Samples of Cistern Water.

Lambeth Company.

126, *Waterloo Road.*—Collected 5th September 1854, by Dr. Hassall and Dr. Thomson.

This water was clear and bright, and in it, after subsidence, there were discovered only three or four minute infusoria. A very small quantity of sediment only was deposited, which contained scarcely any infusoria, there were a few spiculæ of fresh water sponge and frustules of a species of navicula, of cyclotella and of synedra; also a few exuvial masses, and part of a dotted duct or vessel.

This sample of water may be regarded as a very favourable one of Lambeth water as now supplied.

West Middlesex Company.

77, *Upper Berkeley Street.*—Collected 28th September 1854, by Dr. Headlam Greenhow.

This water was somewhat dull and opaque; it was found to contain, after subsidence, one or two paramecia, a good many infusoria, and one polyarthra. The residue was rather considerable, and contained numerous infusoria, including one oxytricha and many vorticellæ, a few amœbæ, and a good number of actinophrydes, apparently of two species, two or three animalculæ of the genus rotifer, the stems or polypedoms of some fresh water zoophyte, frustules of cyclotella operculata, and some of the slender fungus, with much dirt and sandy matter.

Chelsea Company.

12, *Lawrence Street, Chelsea.*—Collected 17th September 1854, by Dr. Headlam Greenhow.

The residue from this water was rather considerable, and of a yellowish colour; it consisted in good part of the yellow fungus so often before referred to, and it did not contain many infusoria, but the following organic and other productions were noticed in it: fragments of shells of entomostraceæ, two or three infusoria of the genus amœba, and a few monads, scenedesmus quadricauda, brown granular corpuscles, a few threads of slender fungus, and several of the pellet-like exuvial masses derived from entomostraceæ.

This water was taken as a fair specimen of the Chelsea water kept in tanks.

Southwark and Vauxhall Company.

Cistern at St. Thomas's Hospital.—Collected October 1854, by Mr. Walker.

The residue in this instance was derived from the subsidence of five gallons of the water, and was so considerable that it would probably have weighed nearly two drachms. It contained numerous large red worms nearly an inch in length, as well as many dozens of smaller annelidæ, of which two species were made out, and several entomostraceæ, also the exuviæ, skins, and shells of the same. It contained likewise hundreds of rotiferæ and vorticellæ. Amongst the vegetable productions, were scenedesmus quadricauda, Sc. lunaris, and several species of pediastra; the diatomaceæ belonged chiefly to the genera Nitzschia and cyclotella. Amongst the dead organic matter were fragments of vegetable tissue, and numerous pieces of altered muscular fibre, these last being doubtless derived from the fœcal matter poured into the river.

Cistern at St. Thomas's Hospital.—Collected October 1854, by Mr. Walker.

Another sample of this water presented the same characters and contained the same abundance of the different kinds of organic matters, dead and living, animal and vegetable, as were noticed in the previous sample.

Hampstead Company.

47, *Arlington Street.*—Collected 10th September, 1854, by Dr. Hassall.

This water, like those obtained from the service pipe of the same cistern from which this sample was procured, possessed a yellowish tinge, and deposited a considerable amount of sediment; this contained a large quantity of organic productions, for the most part of the same genera and species as those present in the specimens from the service pipe; those which were most abundant were two or three different species of pediastrum and scenedesmus, asterionella formosa, a species of lagenella, and two or three species of brown moving sporules.

The general results of the Microscopical Examination of the various specimens of *Cistern Water* have already been stated. The principal conclusion is that the whole of these waters in use in the metropolis abound in organic matter, animal and vegetable, dead and living, their condition being even worse than that of the water as procured from the service pipes.

(6.) RESULTS of the MICROSCOPICAL EXAMINATION of WATER procured direct from the NEW RIVER, the RIVER LEA, and the THAMES, and taken at different points.

RIVER THAMES.

The samples were procured from the river at the following situations:—

Thames Ditton.—This being the highest point from which, at present, any of the Metropolitan Water Companies obtain their supplies.

Chelsea Reach, from which point the Southwark and Vauxhall and the Chelsea Companies still continue to take the water which they supply.

Hungerford Bridge.

London Bridge, and

Greenwich, within a few yards of the Hospital Ship, the Dreadnought.

Thames Water from Thames Ditton.—Collected 3rd September 1854, by Dr. Hassall.

This water was comparatively bright and clear, possessed no appreciable odour, but was somewhat disagreeable to the taste.

In the supernatant liquid there were discovered, by means of the microscope, a considerable number of infusoria; one, and this was the most abundant, was remarkable for the sudden leaps and darts which it took, and belonged to the genus polyarthra; a second kind of animalcule, which was not uncommon, was a species of paramecium; several of each of these, as well as sometimes other infusoria, were contained in nearly every drop of this water, no matter at what depth, as it stood in a half gallon bottle, it was taken for examination.

The deposit which subsided was much less considerable than that from all the other samples examined. Subjected to examination with the microscope, however, it was found to abound in a great variety of forms of infusoria and diatomaceæ, as well as different kinds of fungi; amongst the infusoria may be mentioned species belonging to the genera rotifer, oxytricha, paramecium, and uvella, and amongst the diatomaceæ, broken threads of fragillaria, diatoma, and meloseira.

Hammersmith.—Collected August 1854, by Dr. Hassall.

This water was somewhat dull and opalescent, even after standing twelve hours, but less so than the remaining samples; it was of a faint yellow tint, and its taste was disagreeable.

The supernatant liquid was found to contain numerous animalculæ, many more indeed than the previous sample, and especially a minute paramecium which occurred in greater or less numbers in all the waters examined. There were also present other kinds of infusoria, principally belonging to the genera uvella and euglena, a few diato-

maceæ, principally meloseira varians, and several fronds of pediastrum.

The deposit was many times greater than that from the Thames Ditton water, and it contained a good many infusoria, chiefly of the genera oxytricha and paramecium; it abounded with diatomaceæ, especially naviculæ, and cells of cyclotella operculata and meloseira nummuloides, and there were also discovered in it hairs of wheat fragments of decaying vegetable tissue.

Chelsea Reach.—Collected August 1854, by Dr. Hassall and Dr. Thomson.

After having stood the usual time, the water remained decidedly turbid and opalescent, much more so than the previous sample; it was of a yellow colour, and disagreeable both to the taste and smell.

In every drop of the fluid portion examined, numerous living animal and vegetable productions occurred; the infusoria belonged chiefly to the genera paramecium, coleps and uvella, a few of the peculiar jumping animalculæ already noticed, polyarthræ, also occurred, while there were many green and brown sporules, probably of conferva and diatomaceæ, as well as a few frustules of cyclotella operculata.

The deposit was of a light brown colour and large in quality, very many times larger than that of the Hammersmith water; it consisted, like that of the remaining samples, in great part of earthy matter mixed with various organic substances. There were detected in it rather many infusoria, chiefly vorticellæ, oxytricha pellionella, paramacia, actinophrides, and rotifera, also coleps hirtus, acineta mystacina, and euglena viridis; a great many diatomaceæ, especially Nitzschia sigma, meloseira varians, M. nummuloides, synedra minutissima, cyclotella operculata, and navicula amphisbœna; amongst the desmideæ closterium Ehrenbergii, and pediastrum pertusum were noticed; lastly, much fungus, hairs of animals, of the husk of wheat, and fragments of dead vegetable tissue were present. Figs. 22 and 23.

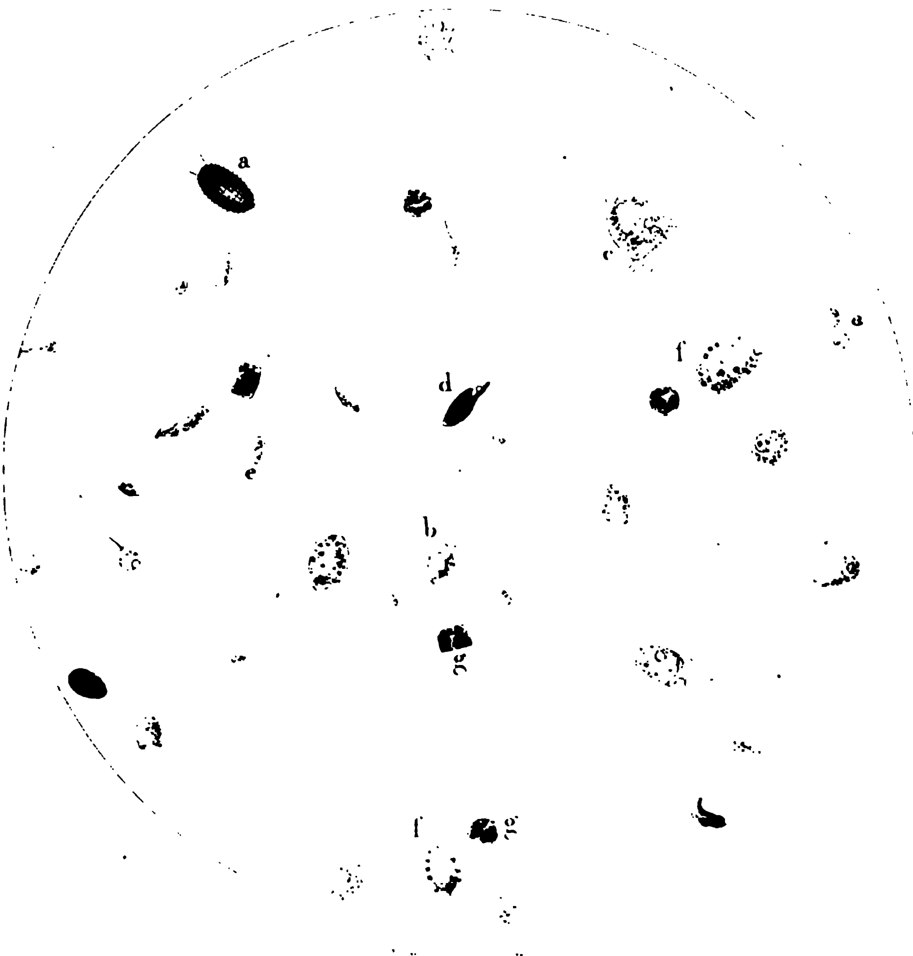
Hungerford Bridge.—Collected August 1854, by Dr. Hassall and Dr. Thomson.

This water was certainly still more opalescent than the Chelsea water, it was more deeply coloured, and smelt and tasted more disagreeably.

The number of living organic productions contained in this water was less than that from Chelsea, although a single drop of it, even after subsidence, could not be taken without some being discovered; there were observed numerous green and brown sporules, animalculæ belonging to the genus euglena, and a few of the polyarthræ already noticed.

The deposit contained but few infusoria, but many diatomaceæ, chiefly cyclotella operculata, Nitzschia sigma, meloseira nummuloides, with a few naviculæ; there were also discovered in it fragments of vegetable tissue, husks of wheat, a few pieces of altered muscular

THAMES WATER AT CHELSEA.
(fluid part.)



a *Coleps hirtus*
b *Paramecium*
c *Polyarthra*
d *Euglena*
e *Monads*
f *Granular resting bodies*
g *Frustules of Cyclotella operculata*

Magnified 200 diameters

a *Anguillula fluviatilis*	g *Actinophrys Sol*	n *Cyclotella operculata*
b *Rotifera*	h *Euglena viridis*	o *Synedra minutissima*
c *Oxytricha*	i *Closterium Ehrenbergii*	p *Melosira varians*
d *Paramecium*	k *Pediastrum pertusum*	r ——— *nummuloides*
e *Coleps hirtus*	l *Nitzschia Sigma*	s *Slender Fungus*
f *Acineta mystacina*	m *Navicula Amphisbaena*	t *Grit & decaying organic matter*

fibre, and some of the black carbonaceous matter derived from the sewers. This water was evidently contaminated with sewage; the deposit was greater from this than from any of the other samples.

London Bridge.—Collected August 1854, by Dr. Hassall and Dr. Thomson.

This water was also opalescent after standing the usual time, and its smell and taste were disagreeable; it contained nearly as many infusoria as the Chelsea water.

The deposit was less considerable, and there were present in it a good many diatomaceæ and infusoria. The animalculæ belonged to the genera paramecium, oxytricha, and actinophrys; the diatomaceæ principally to cyclotella, Nitzschia, and navicula. There were observed in addition one or two of the small river annelid, anguillula fluviatilis, several desmideæ of the genus pediastrum, and filaments of fungus.

The surface of this water, after having stood for some time, became covered with an inidescent pellicle, derived most probably from decomposed organic matter.

Greenwich.—Collected August 1854, by Dr. Hassall and Dr. Thomson.

This water, like the others obtained in the vicinity of the metropolis, was opalescent and of disgreeable taste and smell; it contained a great many animalculæ, though not so many as the Chelsea water.

There were present in the deposit, which was less considerable than that of the waters from Chelsea, Hungerford, and London Bridge, plenty of animalculæ of the genera rotifer, vorticella, actinophrys, and paramecium, a great many diatomaceæ, chiefly of the genera Nitzschia and cyclotella, especially N. sigma and C. operculata, navicula, meloseira, particularly M. nummaloides, and likewise many desmideæ of the genera scenedesmus and pediastrum; lastly, two or three fragments of altered muscular fibre were discovered, and portions of decaying vegetable tissue.

New River Company.

River at Sadler's Wells.—Collected 7th October 1854, by Dr. Hassall.

In this water after subsidence there were discovered a few monads, one group of green sporules, not in motion, and a minute fragment of a dotted duct. After standing at rest, it threw down a large deposit, and there were detected in it a great number of infusoria of various kinds, including two rotiferæ, and a broken shell of same; several euglenæ, one amœba, several small paramecia, a few of a large species, probably paramecium chrysalis, and a great many monads. Amongst the diatomaceæ were frustules of synedra ulna, and of other species of synedra, a few of two different species

of surrirella and pleurosigma, together with filaments of oscillatoria; there was also found some of the usual slender and yellow fungi, spiculæ of the fresh water sponge, and several fragments of husk of wheat.

The threads which we have usually described as those of a yellow fungus bear considerable resemblance, as already remarked, in colour, mode of branching, and in their tapering form, to the stems of the production described by Ehrenberg under the name of anthophysa; it is difficult to identify the genus, in consequence of the absence of the animal; in one or two cases, however, we have seen the uvella-like animalcula attached to the stems.

River Lea.

From New Canal just above the Water Works of the East London Water Company, Bow.

Collected 7th October 1854, by Dr. Hassall and Dr. Thomson.

The fluid part of this specimen of water contained two euglenæ and many infusoria of the genus monas. In the sediment there were discovered a large number of organic productions, living and dead, animal and vegetable. Amongst the animalculæ noticed were two polyarthræ, many euglenæ, and an animalculæ bearing a resemblance to a species of halteria, together with a few paramecia, one oxytricha, and numerous monads. The vegetable productions consisted of diatomaceæ principally and fungi, the former embracing the genera navicula, cymbella, cocconema, pleurosigma, (including one frustule of P. hippocampus,) also a thread of meloseira varians; two pediastra and one closterium] were the only desmideæ seen. Of the fungi three species were found, one in germinating sporules, the usual slender fungus, and the yellow branched production above referred to. Amongst the dead organic matter were portions of the shells of entomostraceæ, and pieces of decaying vegetable tissue.

The following *conclusions* may be deduced from the foregoing Microscopical Examinations of the waters of the Thames, New River, and Lea:—

That organic matter, both dead and living, animal and vegetable, was present in very considerable amount in the whole of the waters subjected to examination.

That in all the waters living animal and vegetable productions were discovered in considerable numbers, and these not merely in the deposit, but in nearly every drop of each of the waters after they had stood the usual time, and after all but the lightest solid matter and the more active living infusoria had consequently subsided.

That nearly all, if not the whole of the living productions noticed, infusoria, diatomaceæ, and desmideæ, belonged to genera and species which have been long known, and which have been described in

systematic works for years; moreover the great majority of them are present in impure waters at nearly all times and seasons.

That amongst the organic productions in the waters of the West Middlesex, Chelsea, and Southwark and Vauxhall Companies were several species, principally diatomaceæ, which occur only in brackish water, as Nitzschia sigma, and meloseira nummuloides. This fact clearly shows that a certain portion of sea water finds its way into the Thames as high up as the sources from whence the above Companies take their supplies. The number of these productions is far less in the water of the West Middlesex Company, and still higher up, as at Kew, they appear to be nearly lost all together. When we consider that a few miles lower down the river, as at Gravesend, the water is quite salt, the fact that Thames water near London should be thus affected need hardly occasion surprise.

That in none of the waters was anything observed which could be supposed to exert any specific effect in the production of cholera.

That the presence of all these various living productions in such large numbers clearly demonstrates the very impure character of the whole of these waters, especially that of the Thames, as taken from the river. Between the samples of water taken near the bridges and that from Thames Ditton a very marked difference was, however, observed.

That two of the samples examined were demonstrably contaminated with sewage was shown by the presence of the black carbonaceous matter so abundant in sewer water, and the fragments of altered muscular fibre.

It should be stated that the several samples examined were procured at low water, there not having been any rain for some days.

There still remains one or two particulars of an interesting character in connexion with Thames water, which may now be referred to. The effect of the incessant traffic of steamers on the river is to keep the water in a state of perpetual commotion, which no doubt assists in breaking up and dissipating the dead organic matter contained in it, and thus powerfully promotes purification. Another consequence of the river traffic is that it stirs up the finer particles of earth, and diffuses them throughout the water; they are thus brought into contact with the fragments of organic matter derived mainly from the sewers, and to which fragments they adhere. Now, there is but little question that the decomposition of the organic matter is greatly modified by this intimate blending with earthy matter, the deodorizing and purifying powers of which have been recently shown to be so great. When Thames water, taken near the metropolis, is held up to the light, it is seen to be studded with particles resembling sand, these do not consist of sand, however, but are really fragments of organic matter, with very fine earthy matter adhering to them; this is shown by the circumstance that if you press these particles, unlike sand, they are found to be quite soft and yielding. Thames water, taken higher up the river, does not present any such appearances.

Some idea of the quantity of organic matter present in the water of

the Thames, near London, may be obtained in the following simple manner:—if a little of the sediment, after being well dried, be held up for a minute or two over the flame of a candle it will emit an odour which is most disagreeable and disgusting, arising from the evolution of gases from the decomposition of the organic matter.

I have already referred more than once to the occurrence in Thames water, near the metropolis, of productions which belong to salt or brackish water, a fact which shows that a certain quantity of that water must actually make its way up the river considerably beyond Chelsea. This one circumstance, independent of all other considerations, is sufficient to condemn the River Thames in this part of its course as a source of supply. The fact that chlorides are frequently present in water near the metropolis in considerable amount has often been noticed. It has hitherto been considered that these were derived almost entirely from the sewage poured into the river, and although there is no doubt but that this is so to some extent, yet unquestionably in many cases the principal part of those chlorides is introduced through the portion of sea water brought up by the tide.

(7.) Results of the Microscopical Examination of some of the Deeper Spring and Well Waters, principally in and near London.

The position assumed in the remarks made introductory to the report on water being correct, viz., that the presence of organic productions, and especially of infusoria, is to be regarded as a sign of impurity, and as an evidence of contamination, then the deeper well and spring waters which have not been exposed to any source of impurity, as by proximity to cesspools or privies, ought to be free, or nearly so, from those evidences of contamination, and they should not contain organic productions, either dead or living, especially the latter, of any kind or description.

In order to ascertain if this be so or not, we have procured specimens of some of the deeper well and spring waters, obtained for the most part in and near London. The results of the microscopical examination of these waters we shall shortly proceed to state.

There are a few precautions which should be observed in the collection and examination of these waters; the bottles should be Winchester quarts, they should be thoroughly cleansed, and they should not have been used for the same purpose before, lest animalculæ or other matters should have been left behind from the previous water.

The sediments or residues, if any, should be separated as in other cases, but the greatest care is requisite that the glasses used for subsidence should be scrupulously clean; lastly, the cells and glass covers used in the microscopical examination of the waters should be new, and should not have been previously employed for the same purpose.

Should it appear as the result of the following examinations, that these waters are free, or nearly so, from living organic productions, then very valuable results will have been arrived at, for standards will have been obtained, by which all waters may be compared as regards their purity and freedom from organic matter, the principal and most injurious contamination to which water is subject.

Further, the fact will be established that there are in nature waters furnished in abundance, and capable of being supplied for domestic use, which are for the most part free from contamination with solid organic matters, and which, if present at all, are usually so in quantities scarcely recognisable with the highest powers of the microscope.

Well in Trafalgar Square.—Collected 25th November 1854, by Mr. J. H. Sandwell.

After prolonged examination, not a vestige of solid organic matter was detected in this water.

Artesian Well, Piccadilly.—Collected 16th December 1854, by Mr. Miller.

A very small quantity of sediment, of a yellowish colour, was deposited from this water, but more than might have been anticipated. The infusoria present consisted of one wheel animalcula, rotifer vulgare, and two of the eel-like annelid. In addition, there was a little of at least two different species of fungi, one belonging to the genus dactylium, three pieces of dotted ducts, a fragment of fir-wood, a piece of straw, four or five of the brown ova cases, together with a little grit.

It is evident, from the contents of this water, that it is exposed to some slight source of contamination, probably some of the waste and rain waters may make their way into the well through the grating beneath the pump.

Pump in Vigo Street.—Collected 16th December 1854, by Mr. H. Miller.

There was scarcely a particle of sediment from this water visible to the unaided eye. No infusoria of any kind were present in it, but it contained a good many of the brown ova cases, single and in masses, one bunch of threads of the slender fungus, several minute fragments of decaying vegetable tissue, and a little gritty matter.

Spring in Kensington Gardens.—Collected 25th November 1854, by Mr. J. H. Sandwell.

In this water but one minute animalcule was seen, two or three sporules of a species of fungus, and a little organic debris.

Spring in Hyde Park.—Collected 11th December 1854, by Mr. J. H. Sandwell.

Degree of Hardness, 16·5°.

No sediment was deposited from this water, neither were any living organic productions discovered by means of the microscope.

Well in Camden Town.—Collected 30th November 1854, by Mr. J. H. Sandwell.

There were detected with the microscope in this water only five or six minute monads, and a very few yellow fragments, composed, probably, of decayed organic matter.

Well at Messrs. Barclay and Perkins'.—Collected 23d November 1854, by Mr. J. H. Sandwell.

After having stood some time, this water deposited a few brownish fragments, composed apparently of decayed organic matter, together with a minute fragment or two of decaying vegetable tissue; the only living productions discovered were two minute infusoria, about the size of monads.

Well at Messrs. Combe, Delafield, and Co.'s—Collected 24th October 1854, by Mr. J. H. Sandwell.

Degree of Hardness, 5°.

In this water but two minute infusoria were seen, and a very few crystals of carbonate of lime.

Well at Messrs. Meux and Co.'s—Collected 27th November 1854, by Mr. J. H. Sandwell.

A very minute quantity of sediment subsided from this specimen, which consisted of brown amorphous matter, with a little grit, no organic productions seen, except a few stationary vibriones in clusters.

Well at Messrs. Whitbread and Co.'s—Collected 27th November 1854, by Mr. J. H. Sandwell.

Scarce a trace of sediment subsided from this water, all that could be discovered was a very minute quantity of yellowish matter, and a few particles of grit. Not a single animalcule of any description was present.

Well at Messrs. Reid and Co.'s—Collected 27th November 1854, by Mr. J. H. Sandwell.

Not a particle of sediment nor a single organic production could be detected in this specimen of water.

Well at Messrs. Calvert and Co.'s—Collected 27th November 1854, by Mr. J. H. Sandwell.

After standing for some time, a little brownish amorphous matter was deposited; in this was discovered, with the microscope, one eel-like annelid, a single thread of oscillatoria, a little slender fungus, and a few minute fragments of decaying vegetable tissue.

Well at St. Bartholomew's Hospital.—Collected November 1854, by Mr. J. H. Sandwell.

A very minute quantity of sediment was deposited from this water, Amongst the infusoria found in it were six or seven of a species of eel-like annelid, differing from the ordinary river worm in the form of the tail, which was prolonged into a kind of hair or bristle, a rotifer, and several small oxytrichæ. Amongst the vegetable pro-

ductions, one large thread of a green conferva, a navicula, and some of the slender fungus were seen; it also contained a piece of firwood, and rather many other fragments of dead and decaying vegetable tissue, and a little gritty matter.

Well at Tottenham.—Collected 29th November 1854, by Mr. J. H. Sandwell.

This specimen of water at first presented a slightly reddish tinge, and threw down, after standing for a time, a considerable deposit, also of a reddish colour, and which was gritty, the colour was probably due to the presence of carbonate of iron. Not a single animalcule seen, or any other description of organic production.

Well at Tooting.—Collected 30th November 1854, by Mr. J. H. Sandwell.

This water presented a dull and opalescent appearance, but not a single living production of any kind or description was discerned in it.

Spring at Watford.—Collected 24th November 1854, by Mr. J. H. Sandwell.

Degree of Hardness, 18·5°.

This water was perfectly clear and bright, and after having stood the usual time, the only organic productions found in it were five or six minute infusoria, about the size of monads, no other solid matter of any description was seen in this water, with the exception of a few groups of crystals of carbonate of lime.

Surface water at Farnham.—Collected 6th December 1854, by J. M. Paine, Esq.

In this water there was observed, with the naked eye, a small quantity of debris, of a reddish colour. After subsidence, rather many infusoria of the genus monas were detected, and five or six larger species of infusoria, together with four of the eel-like annelid, anguillula fluviatilis; there was present in it also a small quantity of the thallus of a fungus, and two or three fragments of decaying vegetable tissue.

The same, from tap at Mr. Paine's House.—Collected 16th December 1854, by J. M. Paine, Esq.

After standing at rest, this water threw down rather much sediment of a dirty brown colour, in which were seen several organic productions. Amongst the living ones were found a stentor, three rotifera, the same number of vorticellæ, two or three oxytrichæ, a paramecium, a few monads and some vibriones, together with threads of the slender fungus; the dead organic matter consisted of numerous pieces of decaying vegetable tissue.*

* These two waters, being nether spring nor well waters, but surface water, are exceptional, and ought scarcely to have been described in the same Report as the other waters.

Spring at Waddon Farmyard, adjoining Beddington.—Collected 23d November 1854, by Mr. J. H. Sandwell.

Degree of Hardness, 12°.

This water let fall a small quantity of brown sediment, chiefly organic. In this, only three infusoria were seen, viz., two annelidæ and one other rather large animalcule. It abounded, however, in vegetable productions of different genera and species, as follows:—numerous threads of confervæ, embracing two species of vesiculifera threads of oscillatoria, zygnema and lyngbya. Of the desmideæ, three fronds of pediastra only were seen, but a good many diatomaceæ, which included especially meloseira, two species, as M. varians and M. arenosa, navicula, pinnularia, nitzschia, and fragillaria, with a few frustules of two or three species of synedra.

Amongst the dead organic matter were broken pieces of shells of daphnia, many fragments of spiral vessels, and other decaying vegetable tissue.

Well at Messrs. Allsopp's, Burton-on-Trent.—Collected 30th November 1854.

After subsidence, not a single animalcule, even a monad, could be discovered in this water. The only solid contents which were present were a few simple and aggregated vibriones, and the threads and sporules of a fungus, one small piece of firwood, and three or four fragments of decaying vegetable tissue.

Well at Messrs. Allsopp's.—Collected 30th November 1854.

A second specimen of Burton water was subjected to microscopical examination, and this was found to be equally free from animalcula or infusoria.

Mr. Allsopp, in a letter, gives the following account of the Burton wells:—"They are not more than 32 feet in depth and about 21 feet in diameter; they take their source from some hills in the neighbourhood, which abound in gypsum, and the water passes through gravel and a stratum of quicksand, which often impedes the operations of the borer."

Well at Messrs. Bass and Co.'s, Burton-on-Trent (Old Brewery).—Collected 1st December 1854.

A minute quantity of sediment visible to the naked eye subsided from this water; in it there were discovered several infusoria, embracing the following genera:—two of the eel-like annelid, eight of the usual species of vorticella, also one of another species, and five or six monads; it likewise contained sporules and threads of fungi, some of the brown ova cases before referred to, five or six very small fragments of decaying vegetable tissue and some yellow organic debris.

Well at Messrs. Bass and Co.'s, Burton-on-Trent (New Brewery).—Collected 1st December 1854.

This specimen of water was procured from another well on the premises of Messrs. Bass and Co. The only living productions discovered were one monad and three or four threads of the slender fungus.

The following are Samples of the Water of the WOOLWICH, PLUMPSTEAD, and CHARLTON COMPANY.

Covered Reservoir.—Collected 16th December 1854, by Dr. Hassall and Professor Clark.

Degree of Hardness, 8·25°.

Not the smallest particle of organic matter of any description was present in this water, but only a minute deposit of microscopic crystals of carbonate of lime.

Tap of House of Mr. Rickston, Woolwich.—Collected 16th December 1854, by Dr. Hassall and Professor Clark.

Degree of Hardness, 8·25°.

The only evidence of the existence of organic matter discovered in this water was a single infinitessimal animalcule; minute crystals of carbonate of lime were rather more abundant in this than in the previous sample.

Well.—Collected 16th December 1854, by Dr. Hassall and Professor Clark.

Degree of Hardness, 21·75°.

Not a single living organic production or other solid trace of organic matter could be discovered in this water; the deposit of carbonate of lime was two or three times more considerable in this than in either of the two previous specimens.

The results of the examination of the three waters above described, obtained from the works of the Woolwich, Plumpstead, and Charlton Water Company, are satisfactory in a high degree, because they afford convincing proof of what may be actually and practically accomplished, as relates to the presence of infusoria and other organic matter in water. Here we have an example of a deep well water free from organic matter as taken from the well, equally so as furnished to the consumer. These results are the more satisfactory since they are obtained without having recourse to filtration; the natural purity of the well water, together with the effect of the softening process, being such as to render filtration unnecessary, there being, in fact, nothing to separate from the water by filtration. The case of this Water Company affords satisfactory evidence of the utility of Professor Clark's softening process. This water, Professor Clark states, as it comes from the well, has a hardness of about 21·75 degrees, and this, after softening, is reduced to 8·25 degrees, all of which, with the exception of 1·6 degree, is due to neutral salts.

With a view to obtain a further proof of the comparative freedom of this water from organic matter, I examined some of the chalk which was deposited after the addition of the hydrated lime; I found it to be perfectly white, to exhibit no evidence of organic matter under the microscope, and to evolve no odour of organic matter when burned.

The contrast between this chalk and that which is deposited in kettles, boilers, &c., after the boiling of Thames water is remarkable,

the one being as white as the purest chalk, and the other of a deep and dirty yellow colour.*

It thus appears from the above examinations of SPRING and WELL water:—

That the majority of the different specimens of deep well and spring waters examined were remarkably free from organic matter. In many, not a single living organic production of any kind was to be discovered; while in the remainder, with the exception of the Wadden water and one of the two samples of Farnham water, the number of organic productions was exceedingly small.

That in none of the waters, with the exception of that from Wadden, were any organic productions found belonging to the orders conferveæ, desmideæ, and diatomaceæ, and rarely any belonging to the class of fungi, so many species of which are almost invariably present in nearly all the river waters in use in the metropolis.

That in those cases in which organic matter, or living organic productions, were discovered, their presence was readily to be accounted for, by reference to special circumstances connected with each case. Thus, the water from the Wadden spring is in immediate communication with a shallow pond full of plants, weeds, &c., and the productions found in this water were, therefore, no doubt derived from the pond in question. In other cases, much of the organic matter present consisted of fragments of decaying vegetable tissue and of other matter which had evidently been introduced into the water from without, the surface of the wells being, in many instances, uncovered and exposed.

Had certain of these waters not been exposed to these comparatively slight sources of contamination, and had, perhaps, still greater care been exercised in the method of procuring them, we have good reason for believing that scarcely a single organic production of any kind would have been found in any one of the well and spring waters subjected to microscopical examination.

We have thus then obtained convincing and positive evidence that THE DEEPER WELL AND SPRING WATERS ARE, FOR THE MOST PART, AND WHOLLY WHEN NOT EXPOSED TO SOURCES OF CONTAMINATION, FREE FROM ORGANIC PRODUCTIONS OF EVERY DESCRIPTION.

It is interesting to contrast the results of the examination of the above waters with those furnished by the waters of the different Companies which take their supply from the Thames, especially the Southwark and Vauxhall Company. While, in the case of many of the former, not a single organic production was to be dis-

* There are two other circumstances which have been reported to me in reference to the Plumstead water which may here be mentioned. One is that the softening process exerts a marked effect over the growth of vegetation in the water when subjected to exposure. In the unsoftened or partially softened water a green vegetation is apt to appear, while in that which has been softened no such growth occurs. The second particular is that the water when pumped up from the well has a temperature of about 45° Fahr., and being kept first in deep, open, softening reservoirs, and afterwards being stored in covered receptacles, it becomes but little reduced in temperature. The consequence of this is that it scarcely ever freezes even in the coldest weather when in the reservoirs, and is much less apt to do so in the distributing pipes than ordinary river water, a source of very great inconvenience being thereby to a great extent avoided.

covered, in the latter, dozens of species belonging to different classes and orders of living organic productions were commonly to be met with in abundance.

It is, therefore, entirely unnecessary that the waters supplied for domestic purposes should contain animalculæ or any other organic productions. The majority of nearly all the spring and well waters which are not specially contaminated are, as has already been shown, free from them, as is also rain water, the water derived from the melting of snow and hail, and fresh distilled water.

If impure water be a source of disease, especially epidemic disease, there is no question but that it is so principally through the organic matter contained in it, and hence the importance of supplying water which is, as near as practicable, free from organic matter.

The only objection to certain well and spring waters is their hardness; this, however, can scarcely, under any circumstances, be a source of epidemic disease, although it is possible in some cases, where the water has been very hard indeed, and where it has been long used, that it may be productive of certain urinary affections. On the other hand, a great many well waters are not hard at all; moreover, the quality of hardness is one that admits of remedy.

A very striking proof of the difference in the keeping properties of pure and impure waters is shown by the following simple proceeding:—If two wide-mouthed glass jars, holding each about a gallon, be filled, one with pure well water, and the other with river water, and loosely covered and exposed to the air, light, and sun, one will usually remain without perceptible change for weeks, and even months, while the sides of the other glass will become coated with green and brown, owing to the development of confervæ, desmideæ, and diatomaceæ. This difference is mainly explained by the freedom of the well water from organic matter, the river water not only containing organic matter, but also the seeds or germs of a variety of organic productions, ready to become developed the moment that circumstances concur favourable to their growth.

I am informed, however, by Professor Clark, that vegetable productions are apt to become developed in hard chalk waters when exposed to air and light, but that no development of them takes place for weeks, and even for months, in the water, after having undergone the softening process.

CONCLUDING REMARKS.

From all that has now been advanced in reference to the condition of the water supplied by the different Metropolitan Water Companies, it appears that, during the period of this inquiry, when the cholera epidemic prevailed, as well as subsequently, the waters furnished by those companies were very far from possessing the requisite purity, in consequence of the large quantity of organic matter (which is the worst contamination to which water can be subjected) contained in them. Even in the water supplied by the Lambeth Company, which is comparatively the purest of the whole,

organic productions, dead and living, animal and vegetable, are found in not inconsiderable numbers, and this water furnishes the type of that with which, in 1855, the greater part of London and its vicinity will be supplied, in accordance with the recent Act by which the water supply of the metropolis was regulated.

The metropolis, then, after that year will still continue to be supplied with river waters containing various kinds of organic matter, including numerous living productions. Now, that there is no necessity that this should be, has been clearly proved by the case of the Woolwich, Plumstead, and Charlton Water Company, which supplies a water entirely free from living organic productions of every description, as also by the condition of most deep wells and spring waters.

The present condition of the water supply of the metropolis not being satisfactory, and it being but little probable that it will be so at the expiration of the period above referred to, it may be well to bestow a few remarks upon the further steps which might be taken with a view to its increased improvement. One step which should certainly be adopted is the substitution of the constant for the intermittent system of supply, as that would entail the abolition of cisterns, butts, tubs, &c., with all their great and concomitant evils; I trust that the legislature will insist upon the fulfilment of this important proviso of the recent Metropolitan Water Act.

It is questionable whether by any process river water can, under any circumstances, be supplied of the requisite degree of purity, owing to the thousand sources of contamination to which this description of water is subject. To afford even a prospect of its being so, it is necessary that a method of filtration should be practised much more effectual than that at present adopted. It is further well worth full consideration as to whether benefit would not result from the employment of Clark's softening process; by this means, especially if combined with filtration, a great portion of the organic matter contained in river waters might undoubtedly be got rid of.

If the metropolis had to be supplied with water anew, rivers ought not to be had recourse to at all. A large supply of water of the purest description may undoubtedly be obtained from deep wells and springs, and be delivered to the consumer on the constant system of supply, free from every description of solid organic impurity.

Having frequently noticed a great difference in the quantity of living organic productions contained in different samples of the water of the same Company, professing to supply only filtered water, I am led to make the inquiry, Whether is it possible for a Company to supply water at one time filtered and at another not? Whether, in fact, are the works so constructed as to render such a thing possible? If it be possible, then have the public no guarantee that they will invariably be supplied with filtered water, even by those Companies which have undertaken to furnish filtered water only. It is of consequence that this point should be clearly ascertained.

Arthur H. Hassall, M.D., F.L.S.

21st Dec. 1854.
Bennett Street, St. James' Street.

TABLES.

TABLE I.

RESULTS of the MICROSCOPICAL EXAMINATION of different WATERS obtained from HOUSES, one or more of the OCCUPANTS of which were either affected or had died of CHOLERA.

Company.	Address.	Cases of Cholera.	Result of Examination.
GRAND JUNCTION COMPANY.	3, South Row, Golden Square.	3 Deaths.	These waters all contained much dead and living organic matter of various kinds, in the solid form. The living productions met with belonged to several distinct classes and genera, and included annelidæ, entomostraceæ, infusoria, desmideæ, diatomaceæ, and fungi. Amongst the most abundant productions met with were pandorina morum, asterionella formosa, and a brown rolling lenticular body, which was very abundant in all the waters of the Golden Square district.
	5, South Row, Golden Square.	3 Deaths.	
	39, Broad Street, Golden Square.	3 Deaths.	
	13, Marshall Street, Golden Square.	4 Deaths and 2 other cases.	
	14, Cambridge Street, Golden Square.	2 Deaths.	
NEW RIVER COMPANY.	23, Peter Street, Golden Square.	6 Deaths.	The above observations apply equally to these waters, the number and variety of organic productions being fully as great. There was this difference, however, that some of the species present in the waters of the Grand Junction Company, as asterionella formosa and pandorina morum, were absent from these, which contained, however, other species not present in the water of the Grand Junction Company, as nitzschia sigmoidea and pleurosigma acuminatum. The brown lenticular bodies were equally abundant in the waters of both Companies.
	9, Hopkins Street, Golden Square.	8 Cases.	
	11, Hopkins Street, Golden Square.	3 Deaths and 2 other cases.	
	5, Berwick Street, Golden Square.	5 Deaths and 2 other cases.	
	3, Broad Street, Golden Square.	3 Deaths.	
	10, Portland Mews, Golden Square.	3 Deaths and 2 other cases.	
	9, Broad Street, Golden Square.	6 Deaths.	
	3, Allen Street, Clerkenwell.	5 Deaths.	
	6, Allen Street, Clerkenwell.	2 Deaths.	
	13, Broad Yard, Clerkenwell.	1 Death.	
	15, Broad Yard, Clerkenwell.	1 Death.	

Lambeth Company	107, Cornwall Road, Waterloo Road.	1 Death.	Living organic productions were present in the whole of these waters, including annelidæ, entomostraceæ, infusoria, desmideæ, diatomaceæ, and fungi; their numbers were not, however, so great as in the waters of the Grand Junction and New River Companies. The Lambeth Company now obtains its supply of water from the Thames at Thames Ditton, to which source several of the other Metropolitan Water Companies are about to have recourse; the fact, therefore, of the presence in this water of various kinds of living organic productions is of very great importance, because it shows that, even when the provisions of the recent Metropolitan Water Bill are carried into effect, London will still continue to be supplied with water of an impure character.
	111, Cornwall Road - -	1 Death.	
	17, Comercial Road, Waterloo Road.	1 Death.	
	66, Wootton Street, Waterloo Road.	1 Death.	
	4, Little King Street, Kent Road.	2 Deaths.	
	21, Bollinbrooke Row, St. Peter's, Walworth.	2 Deaths.	
	1, Bedford Court, St. James's Buildings.	3 Deaths.	
	22, Carter Street, Walworth -	1 Death.	
Southwark and Vauxhall Company.	154, Waterloo Road - -	1 Death.	These waters actually swarmed with living organic productions of various kinds, the majority of the different kinds being identical with those found in the Thames at the point from which this Company obtains its supplies. Amongst them were certain species of diatomaceæ, ordinarily found only in salt or brackish waters, as particularly Nitzschia sigma, and meloseira mummuloides. This occurrence of these diatomaceæ clearly shows that a portion of sea water makes its way up the Thames as far as the source of supply of this Company and the Chelsea Company. Coupling this fact with the large number of living organic productions contained in it, it is clear that this is a highly impure water, and is
	131, Waterloo Road - -	1 Death.	
	15, Eaton Street, Waterloo Road.	1 Death.	
	29, Wootton Street, Waterloo Road.	1 Death.	
	10, Berkeley Terrace, St. Peter's, Walworth.	2 Deaths.	
	25, Bollinbrooke Row, Walworth.	2 Deaths.	
	Flora Cottage, Bermondsey -	2 Deaths and 5 other cases.	
	Batchelor's Guano Manufactory, Bermondsey.	2 Deaths.	

TABLE I.

Results of the Microscopical Examination of different Waters, &c.—*continued.*

Company.	Address.	Cases of Cholera.	Results of Examination.
	9, Prospect Row, Bermondsey.	2 Deaths.	wholly unfit for use as a beverage. In some of the samples examined portions of husk of wheat, cells of potato, and other vegetable substances, starchy matter, and fragments of striped muscular fibre, were met with, demonstrating clearly the fact of the contamination of this water with fæcal matter derived from the sewers.
	13, Clanden Street, Newington.	2 Cases of Cholera, and 2 of Diarrhœa.	
	28, Clanden Street.	1 Death, and 1 case of Diarrhœa.	
	29, Clanden Street.	2 Deaths, and 1 case of Diarrhœa.	
CHELSEA COMPANY	3, Eatley's Buildings, Chelsea.	1 Case of Cholera and 4 of Diarrhœa.	The whole of these samples contained living organic productions of various kinds, the species being for the most part the same as those present in the water of the Southwark and Vauxhall Company, although in greatly diminished numbers. This result is just what might have been anticipated when it is remembered that the Chelsea Company obtains its supplies from nearly the same part of the river as the Southwark and Vauxhall Company, but that it filters the water previous to distribution.
	53, Queen's Road West, Chelsea.	2 Deaths and 2 cases of diarrhœa.	
	4, Bolton's Gardens, Chelsea.	5 Deaths; Diarrhœa general.	
	Wink's Court, Chelsea.		
EAST LONDON COMPANY.	Allen's Cottages, Whitechapel.	1 Death.	Contains various forms of living organic productions belonging to different classes and genera.
	25, Willis Street.	1 Death.	

KENT COMPANY -	5, Duke Street, Deptford.	1 Death.	Contains various forms of living organic productions belonging to different classes and genera, but on the whole fewer than the water of the East London Company.
	97, New Street, Deptford.	6 Deaths.	

Nearly all the organic productions met with in these waters belonged to genera and species which have long been known, and the descriptions of the majority of which are to be found in various systematic works treating of different branches of Natural History. In none of the many specimens examined was any peculiar living production met with which could be supposed to exert any direct or specific effect in the production of Cholera. The whole of the waters subjected to microscopical examination were undoubtedly impure, and this impurity, there is much reason for believing, was not without effect in giving rise in some instances to Cholera. The inquiries made in relation to the condition of the water of the Southwark and Vauxhall Companies, and the occurrence of Cholera, appear to bear out this conclusion.

The only productions met with in any of the waters examined which excited any degree of suspicion that they might possibly have some connexion with Cholera were the brown, lenticular, actively moving bodies, found in nearly all the waters from the Golden Square district, and the vibriones which were noticed in some of the waters.

gard to the bodies first referred to, it is sufficient to state, in order to disprove the idea of their connexion with Cholera, were not found in many other waters procured from Cholera houses, while in one or two cases they were met with in waters which had been unattended with the occurrence of Cholera. With respect to the vibriones, these are to be found in impure rly at all times and seasons; the fact of these occurring in such numbers in the rice-water evacuations of Cholera, appeared give some countenance to the idea that their occurrence in water might not be without importance in relation to Cholera.

For further particulars, *see* page 232.

TABLE II.

RESULTS of the MICROSCOPICAL EXAMINATION of different SPECIMENS of WELL and PUMP WATER procured in Neighbourhoods in which CHOLERA was prevalent.

Address.	Results of Examination.
Pump, White Hart Court, Chelsea. Pump, Sun Court, Chelsea. Pump, Broad Street, Golden Square. Wilderness Row, Goswell Road. Well in Bayley's Yard, Clerkenwell. Pump in Cock's Buildings, Putney. Pump in Price's Folly, Putney. Pump, 19, Stratford Grove, Putney. Well at Sevenoaks, Brasted. Well, Miller Corner, Hadley. Well, Newton, Wisbeach. Well, Newton, Wisbeach. Well, Romsey. Pump, Reading Room, Romsey.	The whole of the samples of well and pump water subjected to microscopical examination without a single exception were of a highly impure character. They all contained living organic productions of various kinds, and in the majority of the specimens these were particularly abundant. The organic productions met with belonged principally to the orders entomostracea, infusoria, and fungi. Desmideæ were for the most part absent, and diatomaceæ present in five only of the waters, and in but two specimens were they at all abundant. At least four of the waters were obviously contaminated by infiltration from neighbouring cesspools. The microscopical examination of the water from the Broad Street pump furnished no very striking or important result, but the chemical analysis of Dr. Thomson shows that the impurity of this water was very much greater than from its bright and colourless appearance would have been supposed. It thus appears that a very large proportion of the well and pump waters in use are in a very impure state, and that they require attention quite as much as the water furnished by the metropolitan water companies. For further particulars, *see* page 239.

TABLE III.

the MICROSCOPICAL EXAMINATION of WELL, PUMP, and other WATERS from SANDGATE, obtained during the PREVALENCE of CHOLERA in that Locality.

of Company.	Address.	Cases of Cholera.	General Results of Examination.
VATERWORKS -	Mr. Bateman's, 1, Birch Cottage.		In all, fourteen samples of water from Sandgate were subjected to examination; the whole of these were contaminated with organic matter, dead and living, the quantity in the majority of the specimens being very considerable. The waters examined included several well and pump waters, as also specimens of that supplied by two different water companies.
	Residence of Mr. George.	5 Deaths.	
KESTONE COMPANY -	Residence of Mr. Penrith.	1 Death.	
	Reservoir at Shorncliff.		
	Reservoir at Castle Hill, Sandgate.		
	Main, Belle Vue, Sandgate.		
	Tap at Belle Vue House.		
	Tap, New Inn.		
	Well, Residence of Mr. George.		In none of these waters was any peculiar production met with which could be supposed to exert any direct or specific effect in giving rise to Cholera.
	Well, Residence of Mr. George.		
	Well, Residence of Mr. Marsh.	1 Death, and 4 ill.	
	Well, House opposite Rose Cottage.	5 Deaths.	
	Pump at New Inn.		
	Stream of Mr. Bligh.		*See* page 242.

TABLE IV.

Results of the Microscopical Examination of different Samples of Water, obtained from the Service Pipes of several of the Metropolitan Water Companies.

Company.	Address.	General Results of Examination.
Grand Junction Company -	3, South Row, Golden Square. 13, Marshall Street.	The general results of the examination of these waters agree closely with those which followed from the examination of the samples of water of the several companies taken from cisterns; the water from service pipes represents the condition of the waters as supplied by the companies, while that from the cisterns the state in which it is actually consumed by the public. Organic productions, dead and living, animal and vegetable, were met with in considerable numbers in the whole of the companies' waters, even in that which is comparatively the purest, being the water supplied by the Lambeth Company, taken from the Thames at Thames Ditton. The condition of the water supplied by the Southwark and Vauxhall Company was by far the worst, not merely abounding in a great variety of organic productions of various kinds, but it being contaminated with fæcal matter, derived from the sewers, as shown by the presence of the hairs and husks of wheat, cells of potato and other vegetables, and fragments of striped muscular fibre. Further, the water of this company, of the Chelsea, West Middlesex, and even the Grand Junction Company, were deteriorated by admixture with salt water, as shown by the presence of several living organic productions, chiefly diatomaceæ, which are ordinarily found only in salt or brackish water. The chemical analyses of these waters, as made by Dr. Thomson, supports the correctness of these conclusions, by showing the presence of large quantities of chlorides. The analyses of the water of the Chelsea, West Middlesex, and Hampstead Companies show that they are all of a very impure description, although, with the exception of the Chelsea Company, less so than the water of the Southwark and Vauxhall Company.
West Middlesex Company -	77, Upper Berkeley Street. 77, Upper Berkeley Street.	
Chelsea Company - - -	5, Lawrence Street. 27, Turner Street.	
Southwark and Vauxhall Company.	St. Thomas's Hospital. 12, Neptune Street, Wandsworth Road. Main Crescent Road, Park Road. Main Crescent Road, Park Road. Main Crescent Road, Park Road.	
New River Company - -	3, Broad Street, Golden Square. 9, Hopkins Street, Golden Square.	
East London Company - -	5, Dock Street, Whitechapel. 1, Back Church Lane, Whitechapel.	
Hampstead Company - -	47, Arlington Street, Hampstead Road. 47, Arlington Street.	
Kent Company - - -	Company's Filter, Service Pipe at Works.	For particulars, *see* page 36.

TABLE V.

Results of the Microscopical Examination of Cistern Waters.

In the Report on Water from Cholera Houses, the results of the examination of forty-four samples of cistern water are recorded. It is unnecessary to repeat in this place either the names of the several companies, or the addresses from which the samples were procured. Six other specimens of cistern water were examined, procured from the localities specified in the Table.

Name of Company.	Address.	General Results of Examination.
Lambeth Company - -	126, Waterloo Road.	Every one of the fifty specimens of water from cisterns contained living organic productions, animal and vegetable; and in the great majority of the samples the numbers present were very great. The relative impurity of the several waters corresponds with that of the water of the company by which the cisterns were supplied, with this difference, that in some cases the condition of the waters in the cisterns was even worse; this arising partly from accumulation of organic matter in the cisterns, and partly from the development of other forms of organic productions, particularly entomostraceæ, in those receptacles. The productions met with were for the most part the same as those present in the waters of the different companies as procured from service pipes. *See* pages 252 and 256.
West Middlesex Company -	77, Upper Berkeley Street.	
Chelsea Company - -	12, Lawrence Street.	
Southwark and Vauxhall Company.	St. Thomas's Hospital.	
Southwark and Vauxhall Company.	St. Thomas's Hospital.	
Hampstead Company - -	47, Arlington Street.	

TABLE VI.

RESULTS of the MICROSCOPICAL EXAMINATION of WATER procured direct from the NEW RIVER, the RIVER LEA, and the THAMES, taken at different Points.

River.	Address.	Condition.
THAMES - -	Thames Ditton. Hammersmith. Chelsea Reach. Hungerford Bridge. London Bridge. Greenwich.	These waters, including even that of the Thames from Thames Ditton, of the New River, and of the River Lea, abounded in organic matter, dead and living, animal and vegetable, belonging to different and widely dissimilar orders of productions. The condition of the water of the Thames from Hammersmith to Greenwich was of course much the worst, it containing the greatest number and variety of living productions, and it being moreover, especially near the Bridges, demonstrably contaminated with fæcal and other matters from the sewers, and it also being further deteriorated by admixture with sea water. The number of productions in the water of the New River and River Lea was very great, and the variety of kinds very considerable. *See* page 260.
NEW RIVER -	At Sadler's Wells.	
RIVER LEA - -	Canal near Bow.	

TABLE VII.

Results of the Microscopical Examination of some of the deeper Spring and Well Waters principally in and near London.

Address.	General Results of Examination.
Artesian Well near Trafalgar Square. Artesian Well, Piccadilly. Pump in Vigo Street. Spring in Kensington Gardens. Spring in Hyde Park. Well in Camden Town. Well at Messrs. Barclay's. Well at Messrs. Coombe's. Well at Messrs. Meux. Well at Messrs. Whitbread's. Well at Messrs. Calvert's. Well at Messrs. Reid's. Well at St. Bartholomew's Hospital. Well at Tottenham. Well at Tooting. Spring at Watford. Surface water at Farnham. The same from tap, Farnham. Spring at Weddon, near Bellington. Well at Messrs. Bass'. Well at Messrs. Allsopp's. Well at Messrs. Allsopp's. Well at Messrs. Bass'. From Well belonging to the Woolwich, Plumstead, and Charlton Water Company. From covered Reservoir belonging to the same Company. From House of Mr. Rickson, supplied by the same Company.	The results of the microscopical examination of these waters are satisfactory in the highest degree. It appears, as might have been anticipated, that the deeper well and spring waters, when not exposed to special sources of contamination, and they rarely are so, are absolutely free from living organic productions of every kind and form. Thus there exist in nature waters in abundance, and easily procurable, which are not open to the serious sanitary objections which attach to nearly all the waters by which the Metropolis is at present supplied. Further, the case of the Woolwich, Plumstead, and Charlton Water Company proves that these waters may be supplied to the consumer in a state of almost absolute purity, and entirely free from even the smaller and simpler living forms of organic matter. For further particulars, *see* page 267. For general conclusions, *see* page 269.

No. IX.

Observations on the Filth of the Thames, contained in a Letter addressed to the Editor of "The Times" Newspaper, by Professor Faraday.

Sir,

I traversed this day by steam-boat the space between London and Hungerford Bridges between half-past one and two o'clock; it was low water, and I think the tide must have been near the turn. The appearance and the smell of the water forced themselves at once on my attention. The whole of the river was an opaque pale brown fluid. In order to test the degree of opacity, I tore up some white cards into pieces, moistened them so as to make them sink easily below the surface, and then dropped some of these pieces into the water at every pier the boat came to; before they had sunk an inch below the surface they were indistinguishable, though the sun shone brightly at the time; and when the pieces fell edgeways the lower part was hidden from sight before the upper part was under water. This happened at St. Paul's Wharf, Blackfriars Bridge, Temple Wharf, Southwark Bridge, and Hungerford; and I have no doubt would have occurred further up and down the river. Near the bridges the feculence rolled up in clouds so dense that they were visible at the surface, even in water of this kind.

The smell was very bad, and common to the whole of the water; it was the same as that which now comes up from the gully-holes in the streets; the whole river was for the time a real sewer. Having just returned from out of the country air, I was, perhaps, more affected by it than others; but I do not think I could have gone on to Lambeth or Chelsea, and I was glad to enter the streets for an atmosphere which, except near the sink-holes, I found much sweeter than that on the river.

I have thought it a duty to record these facts, that they may be brought to the attention of those who exercise power or have responsibility in relation to the condition of our river; there is nothing figurative in the words I have employed, or any approach to exaggeration; they are the simple truth. If there be sufficient authority to remove a putrescent pond from the neighbourhood of a few simple dwellings, surely the river which flows for so many miles through London ought not to be allowed to become a fermenting sewer. The condition in which I saw the Thames may perhaps be considered as exceptional, but it ought to be an impossible state, instead of which I fear it is rapidly becoming the general condition. If we neglect this subject, we cannot expect to do so with impunity; nor ought we to be surprised if, ere many years are over, a hot season give us sad proof of the folly of our carelessness.

I am, Sir,

Your obedient servant,

Royal Institution, July 7. M. Faraday.

No. X.

Report on the Chemical Examinations of Rice-water Discharges. By R. D. Thomson.

Specific gravity of rice-water fluid.

The following densities were derived from four cases in St. Thomas's hospital on the 16th October 1854. The specimens were examined as soon after expulsion as possible.

	Specific Gravity.
1	1008
2	1009
3	1008
4	1010
Mean	1008

Although I have found the specific gravity of this fluid in occasional exceptional cases to attain a higher density than the above, which I have quoted as a mean, still the present number is corroborated by a large number of trials made during the preceding and late epidemic. This low density, which corresponds with that of the urine in its most dilute conditions, is sufficient to distinguish the rice-water evacuations from the category of blood serums, which attains a very high specific gravity in cholera; for while the serum of a healthy individual at the same period I have found 1028, that of cholera patients amounted to 1058 in one case, and in another to 1042.

Diffused matter in rice-water excretion.

The amount of matter mechanically diffused through the rice-water evacuations varies very considerably in quantity in different cases, and great difficulty is experienced in estimating with any degree of accuracy the amount, from the obstruction opposed by a filter to the passage of the fluid through its pores. The most abundant matters present are the flocculent bodies which impart the characteristic aspect to the fluid, which have been in their turn viewed as coagulated albumen, epithelial scales, and corpuscles. The amount of silica present in the fluids when these contain much organic matter, is in favour of the idea of the epithelial scales entering into the constitution of the rice-water evacuations. From analogy I think it probable that when this fluid is first exuded into the intestinal canal, it contains fibrine in solution, as is found to be the case with similarly constituted fluids, deposited in the serous cavities, from which fibrine can be separated by the contact action of many solid bodies, such as washed fibrine of blood, and by intermixture with blood serum.

Whether the flocky deposit be in any measure referable to such a source is difficult of decision, since the deposit would occur by contact with the contents of the intestine before the fluid could be subjected to microscopical or chemical investigation. The substances present in smaller quantities are triple phosphate of ammonia and magnesia when the secretion is in its naturally alkaline condition; this salt likewise forms after death in apparently all the mucous fluids, when decomposition takes place and ammonia is evolved. Fat globules are likewise sometimes visible in the rice-water fluid, together with blood corpuscules, which may probably be derived from the abraded surface of the mucous membrane. I have also noticed vibriones, but these are not peculiar to this secretion, since I have observed them in the intestinal contents of other patients in St. Thomas's hospital.

Solid matters in solution in rice-water excretion.

A number of analyses of this fluid was made during the prevalence of the epidemic. The following table, however, which contains a selection, will be sufficient to exhibit the stable condition of this excretion at various periods:

	I. 3d August.	II. 29th September.	III. 9th October.	IV. 16th October.
Water	987·55	991·39	937·05	990·67
Organic Matter	5·06	·97	57·99	2·60
Salts	7·39	7·64	4·96	6·73
	1000·	1000·	1000·	1000·

The first two experiments and the last correspond closely in their results, but the third differs in having a larger amount of organic matter present. This fluid, however, was not obtained in the usual way, but was taken at a *post mortem* examination on the 9th at 1 p.m. from the duodenum and ilium of a nurse who had died the preceding evening at 6 p.m. It contained flakes, vibriones, and ammonia-phosphate of magnesia.

Chemical characters of the rice-water fluid.

On filtration the fluid, in a majority of instances, on the addition of nitric acid yielded slight flocks resembling albumen; a precipitate likewise ensued on the addition of acetic acid and ferrocyanide of potassium; and generally on the application of heat, particularly after a certain amount of evaporation, slight coagulation occurred or a scum formed on the surface. These characters correspond with those of albumen, or at least that form of it which is found in serous fluids. Nitric acid yielded with the fluid a fine pink colour, and in some cases with sulphuric acid a similar change in tint, from which it may be inferred that probably some of the acids of the bile were present in minute quantities. I have likewise detected sugar in some instances, and urea has likewise been observed. No doubt all the constituents of the blood might be sought for successfully by working on sufficiently large quantities of the excretion. The chemical composition of

the residue from the fluid is represented in the following table; the substance was derived from mixed cases by evaporation after filtration.

Composition of rice-water fluid in 20 *grains, and in* 100 *grains.*

		Per Cent.
Organic Matter	6·40	32·000
Silica	·460	2·300
Phosphate of Lime	·150	·750
Insoluble Lime	·100	·500
Insoluble Magnesia	trace	trace
Soluble Magnesia	·171	·855
Potassium	2·230	11·150
Sodium	4·370	21·850
Chlorine	3·180	15·900
Sulphuric Acid	2·441	12·205
Phosphoric Acid	·310	1·550
Carbonic Acid	·380	1·900
	Per 20 Grains.	Per Cent.
Organic Matter	6·400	32·000
Silica	·460	2·300
Phosphate of Lime	·150	·750
Carbonate of Lime	·180	·900
Sulphate of Potash	4·980	24·900
Triphosphate of Soda	·710	3·550
Carbonate of Soda	·920	4·600
Sulphate of Soda	·270	1·350
Chloride of Sodium	·040	30·200
	20·110	100·550

As far as microscopical and chemical evidence can throw light on the subject, there seems no reason to suppose that any substance or organized matter exists in the rice-water capable of communicating the disease from one individual to another or from one animal to another; but as experiments are said to have been instituted on the Continent which support the view that a similar disease can be produced by the administration of human rice-water fluids to small animals, some experiments were instituted for the purpose of elucidating this point. Before intelligence of the German experiments reached this country, the epidemic had left London, and it was necessary, therefore, to obtain the excretion from some other locality affected with the disease. The fluid had all the usual characters, and had been vomited recently; it was allowed to evaporate slowly and spontaneously without the application of heat. During the escape of the aqueous portion, the organic matter in solution began to putrefy and to evolve the odors of decomposition, in accordance with the Continental experiments. The whole of the putrefying residue, amounting to a grain or two, was administered to a healthy mouse. The animal, having been previously starved for some hours, greedily swallowed the bread, which had been soaked in the cholera matter, and continued to feed at intervals on

bread supplied to it, without apparently being in the slightest degree influenced by the putrid diet. The same mouse had been previously subjected to a similar experiment with the putrid contents of the intestines of another patient, who died from some other disease, without suffering apparently any inconvenience. The result of these experiments I do not consider sufficient to refute the statements of the German physiological chemists; but perhaps it may be admitted that they tend to show that experiments bearing in such a striking manner on the essential character of the disease, require repetition before we can with certainty conclude that the intestinal fluids in cholera are possessed of contagious powers.

ROBERT DUNDAS THOMSON, M.D., F.R.S.

St. Thomas' Hospital,
March 1855.

No. XI.

Report on the Microscopical Examination of the Blood and Excretions of Cholera Patients. By Dr. Hassall.

The outward and physical characters of the rice-water evacuations of cholera vary considerably in different samples and in different cases; they vary in colour, consistence, and composition; ordinarily they resemble thin gruel rather than rice water, being thicker and less white and transparent, and sometimes they are of a brown tinge. After being set aside for some time they usually let fall a deposit, the amount of which is subject to great variation, but generally it is considerable, forming in some cases as much as a fourth or a sixth of the entire bulk.

When submitted to examination with the microscope there are detected in most samples molecules and aggregations of molecules, innumerable mucous corpuscles, single and aggregated, of irregular size and form, and which are frequently imbedded in a mucous base, presenting sometimes a fibrous structure, and molecules and globules of oil; it is of these elements, and especially of the granular corpuscles and mucous base, that the deposit which subsides in most samples is principally composed.

In addition to the above, myriads of vibriones were detected in every drop of every sample of rice-water discharge hitherto subjected to examination. Of these vibriones many formed threads more or less twisted, while others were aggregated into masses, which under the microscope presented a dotted appearance.

But some of the specimens possessed characters very different from the above.

In one sample examined there were no granular or mucous corpuscles, or mucous base to be discovered, but in place of them a great number of globules of oil and innumerable minute acicular crystals, some of which were free, but mostly they were aggregated in bundles in the form of rosettes and dumb-bells. The vibriones were present as usual.

The same crystals occurred in another specimen in great numbers. In this case they were mostly single and but seldom aggregated, and there were no large globules of oil, although a good deal of oil was present in the form of molecules and small droplets.

In addition, numerous fragments of muscular fibre, cells of potato, a few starch corpuscles, and fragments of the husk of wheat, were not unfrequently detected in specimens of the rice-water discharge, and in cases in which food had not been partaken of for a considerable time.

The same acicular crystals were likewise seen in small numbers in two or three other samples, and in several prismatic crystals of triple phosphate.

In none of the samples were sporules or threads of any species of fungus present, or a peculiar body of any kind noticed other than the vibriones mentioned, and in none were well-formed cells of cylinder epithelium, that which coats the surface of the villi of the intestines, discovered.

Such is an enumeration of the different elements and constituents detected by means of the microscope in the specimens of rice-water discharge, about twenty-five in number, subjected to examination, and many of which were obtained from different cases. Fig. 26.

The presence of vibriones in the rice-water discharge being, so far as my experience goes, constant, it became of importance to determine the circumstances under which they make their appearance, and especially to ascertain whether they were present in the evacuations when first passed. In order to determine this point I made arrangements to obtain specimens as quickly as possible after being voided. I had a microscope ready for use placed in the Abernethy Ward of St. Bartholomew's Hospital, so that the discharge might be examined immediately that it was passed. In this way I succeeded in examining several samples within two hours of their being voided, and two others from separate cases immediately they were evacuated. In all of these the vibriones were present in large numbers. In one case I examined, in conjunction with Mr. Rainey, some of the rice-water discharge taken direct from the small intestines about twelve hours after death, and in this case also the vibriones equally abounded. In all cases the species was the same.

It thus appears that vibriones are constantly present in the rice-water discharge of cholera, and that they are developed in it during life, and while still retained in the small intestines.

From observations which have been elsewhere recorded* it appears that two of the circumstances necessary to the development of vibriones are a feebly acid, or more usually an alkaline, fluid and organic matter, especially animal, in a state of decomposition more or less advanced.

Now, in the rice-water discharge of cholera both of these conditions are fulfilled. In the first place it is always offensive, sometimes exceedingly so, resulting from decomposition; and in the second it is always, so far as my observations extend, highly alkaline.

We have next to inquire what is the origin or source of these vibriones, and what their relation to cholera?

With respect to the first point, there is no doubt but that there is more than one source for them, setting aside the idea of their spontaneous generation in decomposing organic fluids. It is possible that they may obtain entrance into the stomach and bowels by means of the atmosphere, and it is perfectly certain that they do frequently gain admission through some of the impure waters consumed, in which I have not unfrequently detected the presence of vibriones, sometimes in considerable numbers.

Once introduced into the alimentary canal, they are brought into relation with conditions highly favourable to their development and

* Proceedings of Royal Medical and Chirurgical Society.

propagation, both of which take place with almost inconceivable rapidity; thus they are brought into contact with abundance of organic matter, mostly in a fluid or greatly divided state, and more or less altered by decomposition, and the fluid in which this animal matter is contained is highly alkaline, and its temperature being raised many degrees above that of the external air also promotes greatly the development of the vibriones. Once admitted into the alimentary canal, it is not, therefore, surprising that they should be developed in inconceivable numbers, and with amazing rapidity.

I have made two or three examinations of healthy and natural fæcal evacuations at the time of their being passed, and in these I have detected the presence of comparatively a very small number of vibriones. It is most probable that the development of these in such cases takes place in the lower part of the intestinal canal, as it is there that in healthy digestion incipient decomposition first takes place, but further observations on this point, especially in cases of ordinary diarrhœa, are still required.

That they should not be present, or if present, only in small numbers, in healthy intestinal evacuations, is satisfactorily explained by the fact that the circumstances favourable to their development do not exist in the same degree as in cholera. The disposition to decomposition does not exist to the same extent, neither are the matters discharged equally alkaline.

Without, however, at all supposing that there is any essential or primary connexion between these vibriones and cholera, their occurrence in such vast numbers in the rice-water discharges of that disease is not without interest, and possibly is of importance; thus, their presence seems to indicate that the fluid thrown out into the intestinal canal in cholera, and especially into the small intestines, is in a state more than ordinarily prone to pass into decomposition, and that the fluid itself is more than usually alkaline. A condition of the intestinal discharges more than usually alkaline would assuredly act as a source of irritation to the mucous membrane of the intestines, as alkaline urine does to that of the bladder.

The existence of these vibriones in the evacuations may also possibly explain in some degree the success of sulphuric acid in checking the diarrhœa. Thus, that acid when freely administered destroys the conditions essential to the development of the vibriones, and so destroys the vibriones themselves. Thus, it checks the tendency to decomposition, and lessens or neutralizes the alkalinity of the fluid poured out by the intestines.

The mere presence of such a large amount of decomposing organic matter in the alimentary canal so high up as the small intestines, the principal seat of absorption of the chyle, must exert a seriously depressing influence upon the system.

The next point for consideration in relation to the rice-water evacuation of cholera is the occurrence in it of the acicular crystals noticed.

These crystals were present in large quantities in two only of the samples examined, but a few were detected in two or three other specimens. They therefore do not form a constant element of the rice-water discharge, but possibly the material or substance from

propagation, both of which take place with almost inconceivable rapidity; thus they are brought into contact with abundance of organic matter, mostly in a fluid or greatly divided state, and more or less altered by decomposition, and the fluid in which this animal matter is contained is highly alkaline, and its temperature being raised many degrees above that of the external air also promotes greatly the development of the vibriones. Once admitted into the alimentary canal, it is not, therefore, surprising that they should be developed in inconceivable numbers, and with amazing rapidity.

I have made two or three examinations of healthy and natural fæcal evacuations at the time of their being passed, and in these I have detected the presence of comparatively a very small number of vibriones. It is most probable that the development of these in such cases takes place in the lower part of the intestinal canal, as it is there that in healthy digestion incipient decomposition first takes place, but further observations on this point, especially in cases of ordinary diarrhœa, are still required.

That they should not be present, or if present, only in small numbers, in healthy intestinal evacuations, is satisfactorily explained by the fact that the circumstances favourable to their development do not exist in the same degree as in cholera. The disposition to decomposition does not exist to the same extent, neither are the matters discharged equally alkaline.

Without, however, at all supposing that there is any essential or primary connexion between these vibriones and cholera, their occurrence in such vast numbers in the rice-water discharges of that disease is not without interest, and possibly is of importance; thus, their presence seems to indicate that the fluid thrown out into the intestinal canal in cholera, and especially into the small intestines, is in a state more than ordinarily prone to pass into decomposition, and that the fluid itself is more than usually alkaline. A condition of the intestinal discharges more than usually alkaline would assuredly act as a source of irritation to the mucous membrane of the intestines, as alkaline urine does to that of the bladder.

The existence of these vibriones in the evacuations may also possibly explain in some degree the success of sulphuric acid in checking the diarrhœa. Thus, that acid when freely administered destroys the conditions essential to the development of the vibriones, and so destroys the vibriones themselves. Thus, it checks the tendency to decomposition, and lessens or neutralizes the alkalinity of the fluid poured out by the intestines.

The mere presence of such a large amount of decomposing organic matter in the alimentary canal so high up as the small intestines, the principal seat of absorption of the chyle, must exert a seriously depressing influence upon the system.

The next point for consideration in relation to the rice-water evacuation of cholera is the occurrence in it of the acicular crystals noticed.

These crystals were present in large quantities in two only of the samples examined, but a few were detected in t[illegible] three specimens. They therefore do not form a cons[illegible] rice-water discharge, but possibly the material [illegible]

which they are formed may exist in all the samples, although not in the crystallized state. One of the specimens in which they were detected in great abundance was examined within two hours of its being passed.

These crystals bear a considerable resemblance in form, size, and arrangement, to those which are so often met with in connexion with decomposing oily and fatty matters, and they probably consist of some fatty acid. In the two cases in which they occurred in the greatest abundance no castor oil or oleaginous article of food had been given.

In connexion with the occurrence of fatty matter in the rice-water evacuations of cholera, the following particulars appear to be possessed of interest.

A few days since I received from Dr. Brown, of Hans Place, Chelsea, a bottle containing some rice-water discharge, on the surface of which there were floating some 16 or 17 masses of an intense verdigris green colour; some of these were of about the size and form a kidney bean, but others were smaller and rounder; they were of a soft waxy consistence, and on viewing them with the microscope it was ascertained that they were entirely composed of globules of oil; these globules were large, very soft, and easily made to alter their shape by the slightest pressure, and even by their own weight. The fluid in which these masses floated resembled the ordinary rice-water discharge; there were dispersed throughout it innumerable spherules of oil, having all the characters of those of which the green masses were formed, and from the breaking down of some of which masses these spherules of oil were derived. Around some of the globules, especially the free ones, a membrane precisely like that of ordinary fat vesicles was perceived. Lying loose amongst the oil globules, and in some cases formed apparently out of their investing membranes, were a few crystals, resembling those already described as occurring in certain of the specimens of rice-water evacuations examined; frequently the appearance of crystals on the largest globules was fallacious, and was produced by certain creases or folds in the membranous covering of the globules.

Wishing to obtain as much information as possible respecting these masses, I gave some of them to Dr. Letheby for chemical analysis, whose report concludes with the following remarks:

"It is manifest from the preceding, that the fatty masses consist chiefly of margarin and olein, with a portion of stearin, cholesterin, and bile. It is probable that the green colour is dependent on the last-named substance, though from the fugitive character of the tint I am disposed to think that it might have been owing to that peculiar kind of refraction which Professor Stokes has named *fluorescence.*"

Most of the specimens of rice-water discharge after examination were set aside in my laboratory, and exposed to the air in open vessels, some of them for many days; a scum of vibriones formed on the surface of nearly all, and most of the samples became of a light pea green colour. Although thus exposed, and persons were constantly engaged in the laboratory, no ill effects resulted.

In one fatal case of cholera a portion of the mucous membrane of the duodenum was submitted to microscopical examination. Contrary

to what might have been anticipated, the villi were found to be coated with a well-formed layer of cylinder epithelium; this appears to show that the granular corpuscles contained in the rice-water evacuations proceed principally, if not entirely, from the mucous follicles. No alteration was detected in the villi themselves denuded of their epithelial covering.

Results of the Microscopical and Chemical Examination of Seventy-two Samples of the Urine of Cholera Patients.

As the details of the various observations made would be tedious, I have classified the principal results derived from the examination of the different urines separately in each case, as follows:

Thomas Richardson, St. Thomas' Hospital.

In all, twenty-nine samples of this urine were subjected to observation and examination, commencing from October 15th, this being the first urine passed after twenty-nine hours' suppression, and ending November 13th.

Albumen was ascertained to be present in fourteen samples, viz., in those passed from October 15th to October 28th inclusive, traces only being found in the urine passed on the last date.

Fibrinous casts of the renal tubules were detected in ten samples, from October 15th to November 4th. The casts discovered in the samples of October 27th were tinged with bile.

Oxalate of lime in dumb-bell crystals was also present, as well as a few octahedra of the same in three specimens, those of October 15th and 16th and November 4th.

Uric acid in crystals occurred in the sample of October 19th, and *urates* in those of October 15th and 16th.

Indigo was developed in eighteen samples, from October 19th to November 13th. The largest quantity found was in those of October 19th, 24th, and 27th, there being sufficient on these to form a scum of deep blue over the surface of the urine plainly visible to the naked eye. In some of the other specimens the indigo formed only a thin ring of blue round the edge of the fluid, while in others the quantity was less considerable, and required the aid of the microscope for its detection. The blue which had collected on the surface of the sample passed October 19th was removed, and the urine again left exposed; in a few days a second pellicle of the blue pigment had formed on the surface and around the edge of the vessel, describing a bright blue ring or circle.

Indigo was not detected in the samples passed on certain intermediate dates.

The sugar fungus was found in five of the specimens, in those passed October 15th, 16th, 19th, and November 3d and 4th.

Monads were contained in ten samples.

bread supplied to it, without apparently being in the slightest degree influenced by the putrid diet. The same mouse had been previously subjected to a similar experiment with the putrid contents of the intestines of another patient, who died from some other disease, without suffering apparently any inconvenience. The result of these experiments I do not consider sufficient to refute the statements of the German physiological chemists; but perhaps it may be admitted that they tend to show that experiments bearing in such a striking manner on the essential character of the disease, require repetition before we can with certainty conclude that the intestinal fluids in cholera are possessed of contagious powers.

ROBERT DUNDAS THOMSON, M.D., F.R.S.

St. Thomas' Hospital,
March 1855.

No. XI.

Report on the Microscopical Examination of the Blood and Excretions of Cholera Patients. By Dr. Hassall.

The outward and physical characters of the rice-water evacuations of cholera vary considerably in different samples and in different cases; they vary in colour, consistence, and composition; ordinarily they resemble thin gruel rather than rice water, being thicker and less white and transparent, and sometimes they are of a brown tinge. After being set aside for some time they usually let fall a deposit, the amount of which is subject to great variation, but generally it is considerable, forming in some cases as much as a fourth or a sixth of the entire bulk.

When submitted to examination with the microscope there are detected in most samples molecules and aggregations of molecules, innumerable mucous corpuscles, single and aggregated, of irregular size and form, and which are frequently imbedded in a mucous base, presenting sometimes a fibrous structure, and molecules and globules of oil; it is of these elements, and especially of the granular corpuscles and mucous base, that the deposit which subsides in most samples is principally composed.

In addition to the above, myriads of vibriones were detected in every drop of every sample of rice-water discharge hitherto subjected to examination. Of these vibriones many formed threads more or less twisted, while others were aggregated into masses, which under the microscope presented a dotted appearance.

But some of the specimens possessed characters very different from the above.

In one sample examined there were no granular or mucous corpuscles, or mucous base to be discovered, but in place of them a great number of globules of oil and innumerable minute acicular crystals, some of which were free, but mostly they were aggregated in bundles in the form of rosettes and dumb-bells. The vibriones were present as usual.

The same crystals occurred in another specimen in great numbers. In this case they were mostly single and but seldom aggregated, and there were no large globules of oil, although a good deal of oil was present in the form of molecules and small droplets.

In addition, numerous fragments of muscular fibre, cells of potato, a few starch corpuscles, and fragments of the husk of wheat, were not unfrequently detected in specimens of the rice-water discharge, and in cases in which food had not been partaken of for a considerable time.

The same acicular crystals were likewise seen in small numbers in two or three other samples, and in several prismatic crystals of triple phosphate.

In none of the samples were sporules or threads of any species of fungus present, or a peculiar body of any kind noticed other than the vibriones mentioned, and in none were well-formed cells of cylinder epithelium, that which coats the surface of the villi of the intestines, discovered.

Such is an enumeration of the different elements and constituents detected by means of the microscope in the specimens of rice-water discharge, about twenty-five in number, subjected to examination, and many of which were obtained from different cases. Fig. 26.

The presence of vibriones in the rice-water discharge being, so far as my experience goes, constant, it became of importance to determine the circumstances under which they make their appearance, and especially to ascertain whether they were present in the evacuations when first passed. In order to determine this point I made arrangements to obtain specimens as quickly as possible after being voided. I had a microscope ready for use placed in the Abernethy Ward of St. Bartholomew's Hospital, so that the discharge might be examined immediately that it was passed. In this way I succeeded in examining several samples within two hours of their being voided, and two others from separate cases immediately they were evacuated. In all of these the vibriones were present in large numbers. In one case I examined, in conjunction with Mr. Rainey, some of the rice-water discharge taken direct from the small intestines about twelve hours after death, and in this case also the vibriones equally abounded. In all cases the species was the same.

It thus appears that vibriones are constantly present in the rice-water discharge of cholera, and that they are developed in it during life, and while still retained in the small intestines.

From observations which have been elsewhere recorded* it appears that two of the circumstances necessary to the development of vibriones are a feebly acid, or more usually an alkaline, fluid and organic matter, especially animal, in a state of decomposition more or less advanced.

Now, in the rice-water discharge of cholera both of these conditions are fulfilled. In the first place it is always offensive, sometimes exceedingly so, resulting from decomposition; and in the second it is always, so far as my observations extend, highly alkaline.

We have next to inquire what is the origin or source of these vibriones, and what their relation to cholera?

With respect to the first point, there is no doubt but that there is more than one source for them, setting aside the idea of their spontaneous generation in decomposing organic fluids. It is possible that they may obtain entrance into the stomach and bowels by means of the atmosphere, and it is perfectly certain that they do frequently gain admission through some of the impure waters consumed, in which I have not unfrequently detected the presence of vibriones, sometimes in considerable numbers.

Once introduced into the alimentary canal, they are brought into relation with conditions highly favourable to their development and

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I have made two or three examinations of healthy and natural fæcal evacuations at the time of their being passed, and in these I have detected the presence of comparatively a very small number of vibriones. It is most probable that the development of these in such cases takes place in the lower part of the intestinal canal, as it is there that in healthy digestion incipient decomposition first takes place, but further observations on this point, especially in cases of ordinary diarrhœa, are still required.

That they should not be present, or if present, only in small numbers, in healthy intestinal evacuations, is satisfactorily explained by the fact that the circumstances favourable to their development do not exist in the same degree as in cholera. The disposition to decomposition does not exist to the same extent, neither are the matters discharged equally alkaline.

Without, however, at all supposing that there is any essential or primary connexion between these vibriones and cholera, their occurrence in such vast numbers in the rice-water discharges of that disease is not without interest, and possibly is of importance; thus, their presence seems to indicate that the fluid thrown out into the intestinal canal in cholera, and especially into the small intestines, is in a state more than ordinarily prone to pass into decomposition, and that the fluid itself is more than usually alkaline. A condition of the intestinal discharges more than usually alkaline would assuredly act as a source of irritation to the mucous membrane of the intestines, as alkaline urine does to that of the bladder.

The existence of these vibriones in the evacuations may also possibly explain in some degree the success of sulphuric acid in checking the diarrhœa. Thus, that acid when freely administered destroys the conditions essential to the development of the vibriones, and so destroys the vibriones themselves. Thus, it checks the tendency to decomposition, and lessens or neutralizes the alkalinity of the fluid poured out by the intestines.

The mere presence of such a large amount of decomposing organic matter in the alimentary canal so high up as the small intestines, the principal seat of absorption of the chyle, must exert a seriously depressing influence upon the system.

The next point for consideration in relation to the rice-water evacuation of cholera is the occurrence in it of the acicular crystals noticed.

These crystals were present in large quantities in two only of the samples examined, but a few were detected in two or three other specimens. They therefore do not form a constant element of the rice-water discharge, but possibly the material or substance from

which they are formed may exist in all the samples, although not in the crystallized state. One of the specimens in which they were detected in great abundance was examined within two hours of its being passed.

These crystals bear a considerable resemblance in form, size, and arrangement, to those which are so often met with in connexion with decomposing oily and fatty matters, and they probably consist of some fatty acid. In the two cases in which they occurred in the greatest abundance no castor oil or oleaginous article of food had been given.

In connexion with the occurrence of fatty matter in the rice-water evacuations of cholera, the following particulars appear to be possessed of interest.

A few days since I received from Dr. Brown, of Hans Place, Chelsea, a bottle containing some rice-water discharge, on the surface of which there were floating some 16 or 17 masses of an intense verdigris green colour; some of these were of about the size and form a kidney bean, but others were smaller and rounder; they were of a soft waxy consistence, and on viewing them with the microscope it was ascertained that they were entirely composed of globules of oil; these globules were large, very soft, and easily made to alter their shape by the slightest pressure, and even by their own weight. The fluid in which these masses floated resembled the ordinary rice-water discharge; there were dispersed throughout it innumerable spherules of oil, having all the characters of those of which the green masses were formed, and from the breaking down of some of which masses these spherules of oil were derived. Around some of the globules, especially the free ones, a membrane precisely like that of ordinary fat vesicles was perceived. Lying loose amongst the oil globules, and in some cases formed apparently out of their investing membranes, were a few crystals, resembling those already described as occurring in certain of the specimens of rice-water evacuations examined; frequently the appearance of crystals on the largest globules was fallacious, and was produced by certain creases or folds in the membranous covering of the globules.

Wishing to obtain as much information as possible respecting these masses, I gave some of them to Dr. Letheby for chemical analysis, whose report concludes with the following remarks:

"It is manifest from the preceding, that the fatty masses consist chiefly of margarin and olein, with a portion of stearin, cholesterin, and bile. It is probable that the green colour is dependent on the last-named substance, though from the fugitive character of the tint I am disposed to think that it might have been owing to that peculiar kind of refraction which Professor Stokes has named *fluorescence*."

Most of the specimens of rice-water discharge after examination were set aside in my laboratory, and exposed to the air in open vessels, some of them for many days; a scum of vibriones formed on the surface of nearly all, and most of the samples became of a light pea green colour. Although thus exposed, and persons were constantly engaged in the laboratory, no ill effects resulted.

In one fatal case of cholera a portion of the mucous membrane of the duodenum was submitted to microscopical examination. Contrary

to what might have been anticipated, the villi were found to be coated with a well-formed layer of cylinder epithelium; this appears to show that the granular corpuscles contained in the rice-water evacuations proceed principally, if not entirely, from the mucous follicles. No alteration was detected in the villi themselves denuded of their epithelial covering.

RESULTS of the MICROSCOPICAL and CHEMICAL EXAMINATION of Seventy-two SAMPLES of the URINE of CHOLERA PATIENTS.

As the details of the various observations made would be tedious, I have classified the principal results derived from the examination of the different urines separately in each case, as follows:

THOMAS RICHARDSON, St. Thomas' Hospital.

In all, twenty-nine samples of this urine were subjected to observation and examination, commencing from October 15th, this being the first urine passed after twenty-nine hours' suppression, and ending November 13th.

Albumen was ascertained to be present in fourteen samples, viz., in those passed from October 15th to October 28th inclusive, traces only being found in the urine passed on the last date.

Fibrinous casts of the renal tubules were detected in ten samples, from October 15th to November 4th. The casts discovered in the samples of October 27th were tinged with bile.

Oxalate of lime in dumb-bell crystals was also present, as well as a few octahedra of the same in three specimens, those of October 15th and 16th and November 4th.

Uric acid in crystals occurred in the sample of October 19th, and *urates* in those of October 15th and 16th.

Indigo was developed in eighteen samples, from October 19th to November 13th. The largest quantity found was in those of October 19th, 24th, and 27th, there being sufficient on these to form a scum of deep blue over the surface of the urine plainly visible to the naked eye. In some of the other specimens the indigo formed only a thin ring of blue round the edge of the fluid, while in others the quantity was less considerable, and required the aid of the microscope for its detection. The blue which had collected on the surface of the sample passed October 19th was removed, and the urine again left exposed; in a few days a second pellicle of the blue pigment had formed on the surface and around the edge of the vessel, describing a bright blue ring or circle.

Indigo was not detected in the samples passed on certain intermediate dates.

The sugar fungus was found in five of the specimens, in those passed October 15th, 16th, 19th, and November 3d and 4th.

Monads were contained in ten samples.

The *specific gravity* of the above samples of urine varied from 1004 to 1011, the average gravities being 1006, 1007, and 1009. The sp. gr. of three of the five urines which were found to contain sugar were as follows: October 19th, 1011; November 3d, 1007; November 4th, 1009.

The *reaction* of most of these urines was decidedly acid; in seven of the other samples the acidity was but feeble; while in those passed on October 26th and 27th, and November 1st, 2d, 4th, and 6th, it was neutral.

William Stevens, St. Thomas' Hospital.

Fifteen samples of the urine in this case were received and examined, viz., from October 28th to November 13th.

Albumen was found in six samples, those from October 28th to November 4th, after which it disappeared.

Fibrinous casts, none were seen in any of the above samples.

Oxalate of lime in octahedral crystals was seen in two specimens in large amount, in that of November 8th, and in smaller quantity in that of November 10th. The sugar fungus being present in one, if not both, of these specimens.

Uric acid in crystals, single and aggregated into stellæ, were present in two of the urines, those of October 28th and 31st, and urates in globules or spherules in those of November 4th and 9th.

Indigo was developed in seven of the specimens; in those passed from October 28th to November 13th; in six of the urines the indigo formed a blue ring round the edge of the vessel, in the others the microscope was necessary for its detection.

Indigo was not found in the samples passed on certain intermediate dates.

The sugar fungus was developed in seven of the urines, viz., from October 28th to November 8th.

Monads abounded in seven samples.

The *specific gravity* ranged from 1009 to 1019, but was generally 1011. The sp. gr. of the urines, in which sugar was found, was as follows: 1010, 1011, 1009, 1012.

The *reactions* of the samples were as follow:—Ten were decidedly acid, two feebly acid, and three were neutral.

James Madden, St. Thomas' Hospital.

Nine samples of this urine altogether were examined, the first being that of October 19th, which was passed after twenty-four hours' suppression; and the last, October 27th.

Albumen was present in seven specimens, from October 19th to 27th, and was no doubt also present on the intermediate and some of the following days.

Fibrinous casts were seen in three of the urines—Oct. 19th, 22d, and 26th, and were also, no doubt, for the most part present on the intermediate days.

Urates, in the form of dumb-bell crystals, were present in two samples, October 19th and 23d; in the first of these some of the urate was deposited in the renal casts.

Indigo appeared in eight samples, from October 19th to 27th. The largest quantity was in those of October 19th and 20th, in which it formed a perfect scum over the surface; a good deal of the pigment was also deposited with the sediment. In the remaining specimens the indigo formed a ring of blue round the edge of the fluid, plainly visible to the naked eye. The indigo of two of these samples was collected, and after exposure, the urine deposited a further quantity of indigo.

The sugar fungus was not observed in any of these samples, nor any dumb-bell crystals of oxalate of lime.

The *specific gravity* ranged from 1010 to 1014, the usual gravity being 1011 and 1012.

The *reaction* of these urines was more or less acid, with the exception of those of October 25th and 26th, when it was neutral.

This patient quitted the hospital, October 28th, apparently well, although, as we have seen, the urine had not entirely ceased to be albuminous.

ROBERT QUARRELL, St. Thomas' Hospital.

Two samples of this urine were examined, passed October 12th.

Albumen was found in large quantity in both specimens.

Fibrinous casts, in great numbers, also occurred in both.

Dumb-bell oxalate of lime, in fine large crystals, was found in the second sample.

Uric acid occurred in both, and was very abundant in the second specimen, while *urates* were found only in the first sample.

Indigo became developed in both the urines, more particularly in the second; but at first, in neither case was the quantity large, the microscope being required for its detection. In the second sample the indigo was deposited partly in the thallus both of the sugar fungus and of penicilium glaucum. Although at first no blue visible to the naked eye was developed on the surface of either of the urines, yet after the removal of the scum of fungus which had formed over the surface of the second sample, and on well agitating the urine, in the course of a few days a dense blue scum became developed all over it. The blue colour was probably not developed at first, in consequence of the contact of the air with the surface of the urine being impeded by the pellicle of fungus which had grown over it.

The *sugar fungus*, in perfect fructification, appeared in the second sample.

The *specific gravity* of the sample containing the sugar was 1018.

Reaction of both specimens very acid.

JAMES PALMER, St. Thomas' Hospital.

One sample only of this urine [illegible] was passed October 3d.

Albumen was detected in this uri[illegible]

Renal casts, a few only were seen.

Oxalate of lime in dumb-bells occurred, also a few large octohedral crystals of the same salt.

Indigo appeared in sufficient quantity to form a thin blue scum over the surface; this was collected and the urine again exposed, when after some days a thin ring of pale blue formed round the edge of the fluid.

Specific gravity, 1017. *Reaction*, decidedly acid.

JOHN BRANDON, St. Thomas' Hospital.

Only one sample of urine in this case was examined, this being passed October 5th.

Albuminous, but no *renal casts* were seen, nor was any *indigo* deposited. In the sediment there was found a few large sporules, which had more the appearance of those of the sugar fungus than of penicilium glaucum, but yet were scarcely so large as those of the yeast plant.

Uric acid was rather abundant.

The quantity of this urine obtained was too small to allow of its specific gravity being taken. *Reaction*, decidedly acid.

From St. Thomas' Hospital.

This specimen of urine was passed October 5th.

Albumen was present in small quantity only.

Oxalate of lime in dumb-bells was deposited in very large amount.

Urates were likewise contained in this urine.

The *sugar fungus* was met with in small quantity.

Specific gravity 1014. *Reaction*, decidedly acid.

From St. Thomas' Hospital.

This sample of urine was passed September 29th.

Albumen was present in small amount.

Fibrinous casts, only a few fragments detected.

Neither *Oxalate of lime, sugar fungus*, or *indigo*, were developed in this instance.

Urates of a pink colour were deposited in considerable amount.

Specific gravity of the urine, 1024. *Reaction* very acid.

From St. Thomas' Hospital.

One sample only of this urine was obtained.

Albumen was found in large quantity.

Renal casts in large numbers were likewise present.

Oxalate of lime, in dumb-bell crystals, occurred in considerable quantity.

Indigo appeared on the surface, forming a dense reddish blue scum all over, which was collected; some also was deposited at the bottom of the glass. After the removal of the pellicle first formed, and further exposure of the urine a second thin blue scum was developed on the surface.

The *specific gravity* of the urine was 1016.
The *reaction*, as evidenced by the growth of fungus, was acid.

From St. Thomas' Hospital.

The sample of urine examined in this case was passed October 7th.
Albumen occurred in this urine.
Uric acid in tablets, and also in long straight threads, made up of aggregations of small crystals of the same form, occurred in large quantity. It was particularly observed that the threads of crystals were formed independent of fibres or nuclei.
Indigo was formed in small quantity, which was visible to the naked eye, and many pieces and fragments of it were discovered by means of the microscope.
Bile in small quantity was also present in this specimen, as shown by the manner in which the epithelial cells were coloured or stained with that substance.
Monads occurred in large numbers.
The *specific gravity* was 1010. *Reaction* decidedly acid.

From St. Thomas' Hospital.

This sample of urine was passed October 5th.
Albumen was found in large quantity.
Renal casts, a great number were seen.
Oxalate of lime in dumb-bells, and octohedra a good deal.
Indigo, a few fragments only discovered with the microscope; some of the indigo had also become deposited in the threads of penicilium glaucum.
The *sugar fungus* in perfect fructification was rather abundant.
Specific gravity, 1017. *Reaction* very acid.

Charles Barber.

The specimen of this urine examined was passed October 3d.
Albumen was present in this sample in large quantity.
Renal casts were discovered also, but not many.
Oxalate of lime in dumb-bells occurred, but the number of crystals was but small.
A small quantity of the *sugar fungus* was likewise developed.
Indigo was deposited in sufficient amount to form a blue scum over the whole surface of the urine; this was removed, and the urine again left exposed to the air; in a few days a second deposit of blue took place, forming a thin ring round the edge of the vessel; a great many fragments of the same were likewise discovered with the microscope.
The *specific gravity* was 1012. *Reaction* very acid.

Thomas Bates.

This sample of urine was passed forty-eight hours after collapse.
Albumen was present in rather large amount.
Renal casts abounded in this specimen.

Oxalate of lime, chiefly in dumb-bells, was deposited in large quantity, some of the crystals being formed in the casts of the renal tubules.

Uric acid was present in considerable amount, as also much urate; a good deal of the latter was deposited in the fibrinous casts, and in the epethelial scales which were contained in the urine. Fig. 27.

Indigo did not appear in this urine.

Specific gravity, 1018. *Reaction*, acid.

From Charing Cross Hospital.

The first sample was passed October 4th.

Albumen was found in rather large quantity.

Renal casts were seen in great numbers.

Oxalate of lime in dumb-bells occurred very abundantly, as well as many octohedral crystals of the same.

Urates also were met with, some of which were deposited in the renal casts.

Indigo appeared, forming a reddish blue scum over the whole surface.

PATRICK REILLY, St. Bartholomew's Hospital.

Two samples of this urine were examined, being the first two passed on the subsidence of collapse.

Albumen was present in both urines.

Renal casts also in both, but not in large number.

Uric acid was found in the first urine passed.

Oxalate of lime, in the form of octohedral crystals, was discovered in the second sample.

The *sugar fungus* likewise occurred in the second sample.

Indigo was developed in both samples, but in largest amount in that first passed, in which it formed a decided blue scum all over the surface. In the second specimen the indigo at first only formed a well-defined border round the edge of the glass, but after agitation, in the course of a few days a slaty-blue scum appeared over the whole surface of the liquid.

Monads in large numbers appeared in both urines.

The *specific gravity* of the two samples was 1014 and 1015.

The *reaction* of both decidedly acid.

——— FITZGERALD, St. Bartholomew's Hospital.

Two samples of the urine in this case were examined.

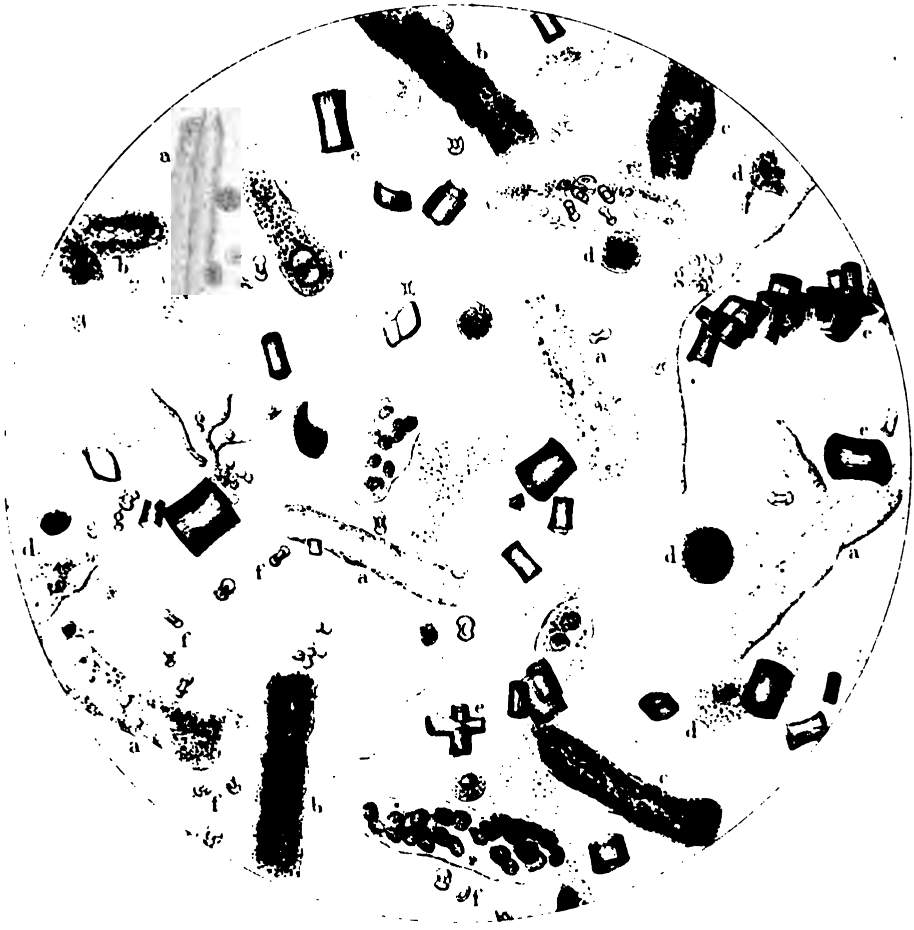
Albumen was found in both the specimens.

Renal casts occurred in both, and in very large numbers in that passed October 4th.

Oxalate of lime in dumb-bells was deposited in the sample of October 4th.

Uric acid in tubular crystals was found in both specimens, together with much *urate*.

Indigo was not formed in either of the urines.



aa Fibrinous casts of the Renal tubules
bb Casts coloured with urate
cc Casts with Dumb bell Oxalate of lime
dd Epithelial scales coloured with urate
ee Crystals of Uric Acid
ff Dumb bell crystals of Oxalate of lime
gg Sporules & threads of Penicilium glaucum

The *sugar fungus* was seen in only one of the samples, viz., that passed October 5th.

The *specific gravity* of the urines was 1017 and 1018.

The *reaction* of both decidedly acid.

From St. Bartholomew's Hospital.

A drachm only of each of the two following samples of urine was forwarded for examination:

Albumen was detected in both samples.

Fibrinous casts of the renal tubules were likewise present in both the urines.

Oxalate of lime in dumb-bell crystals occurred in the two specimens.

The *sugar fungus* likewise became developed in both and attained its perfect fructification, particularly in the second sample, the fungus forming a perfect scum over the entire surface of the urine as it was exposed to the air in a test-tube.

Ellen Godfrey.

This was said to be the first urine passed on recovery from the attack.

Albumen was found in large quantity.

Renal casts were not observed.

Dumb-bell crystals of *oxalate of lime* occurred in rather large number.

Uric acid in crystals a few, as well as much granular *urate*.

Indigo appeared in small amount only, the microscope being requisite for its discovery. Some of the blue pigment was deposited in the epithelial scales contained in the urine.

The quantity of urine sent was too small to allow of its *specific gravity* being ascertained. Its *reaction* was neutral.

It is obvious that there is much in the above results of the examination of the urine of cholera of interest and importance.

The first particular of importance relates to the albuminous condition of the urine. That the urine in cholera is frequently albuminous has long been known; but it now appears that it is almost constantly so, and that this condition of the urine persists for a considerable period after the attack has passed away, facts particularly worthy of notice. I have not met with a single undoubted instance of the absence of albumen from the early samples of urine passed in cases of cholera; while in one or two of the cases here recorded the patients were actually dismissed from the hospital as well, and apparently they were so, although the urine still continued to be albuminous.

The next particular for consideration is the occurrence in the urine of fibrinous casts of the renal tubules. These are almost invariably present in the early samples of urine passed on recovery from the attack of cholera, and sometimes they are to be detected for

a considerable time, occasionally not altogether disappearing until after the urine has ceased to be distinctly albuminous. The urine of cholera presents the best and most perfect examples of this form of renal casts which I have ever met with, the casts being so well defined, abundant, and often containing imbedded in their substance different forms of urinary deposits, as urates, dumb-bell crystals of oxalate of lime, &c. Fig. 27.

Not unfrequently the casts are shaded of a dark colour, in consequence of the quantity of urate imbedded in them. Very commonly, also, dumb-bell crystals of oxalate of lime are met with similarly imbedded, a fact which shows that this salt crystallizes in these cases immediately after the urine is secreted, and while within the renal tubules. Nearly the whole of these particulars are shown in the figure above referred to.

Another important particular is the occurrence of deposits in the early samples of cholera urine voided. These are noticed especially in the first two or three samples passed. They consist of uric acid, urates, and particularly dumb-bell crystals of oxalate of lime.

That the oxalate of lime should be deposited so commonly in the form of dumb-bells, and not in the usual octohedral crystals, is a remarkable fact, and one which seems to show that a very essential distinction exists between these two crystalline forms of what is usually considered to be the same salt.

After the urines have been kept for some days numerous changes are observed to occur in them. The quantity of deposits, especially those of uric acid, urates, and oxalate of lime, often becomes increased, the urines become turbid, alter in colour, fungi are gradually developed in them, and lastly, in many instances, a scum or pellicle of pigment of a blue colour, more or less marked, forms upon their surface.

The formation of a blue pigmentary substance on the urine in cases of cholera has been before noticed, and principally by Heller. That observer bestowed upon it the name of Uroglaucin, and considered it to be a modification of urine pigment.

I have elsewhere shown that indigo is of frequent occurrence in human urine,* and in the communication referred to I advanced certain reasons to prove that the uroglaucin of Heller is really indigo. Of this fact no doubt now whatever remains, as I have succeeded in obtaining from several of the samples of blue pigment procured from cholera urines all the reactions so well marked which characterize indigo. This may be considered to be an important result, and I am now fully convinced that only one blue pigmentary substance is ever formed naturally in the urine, and that this is in all cases indigo; the uroglaucin of Heller and the cyanourin of Scherer being merely impure states or conditions of indigo.

It will be observed, that the yeast-plant or sugar fungus was met with in different samples of the urine in nearly every case. This is another very interesting fact in connexion with the urine of cholera.

* "On the frequent occurrence of indigo in human urine, and on its chemical, physiological, and pathological relations."—*Transactions of the Royal Society*, 1854, p. 297.

Of the value of this fungoid test for sugar I have elsewhere adduced evidence,* but additional proof is now furnished of its great utility. The yeast-plant was met with in different stages of growth in at least fourteen samples, while evidences of its existence were observed in several other specimens. The specific gravity of the urines in which it was actually detected ranged from 1007 to 1018, the average gravities being 1009 and 1011; by no other single and direct test could sugar, when present in urine in amount comparatively so small, be detected. In all probability sugar was present in some of the other samples of urine, in which the sugar fungus had not become developed. Some of these specimens were either neutral or alkaline, and as it is essential for the growth of this fungus that they should have an acid reaction, the fungus therefore did not make its appearance in these samples.

No organic production was present in any of the urines when first passed, neither was any subsequently developed in them which could be supposed to be associated in any way with cholera.

REPORT stating the RESULTS of the MICROSCOPICAL EXAMINATION of numerous SPECIMENS of BLOOD obtained from the BODIES of PERSONS who had died of CHOLERA.

IN all, eighteen specimens of blood were subjected to microscopical observation.

These specimens were in all cases examined a few hours after death, and in some instances almost immediately after dissolution.

The results of the observations made may be thus briefly stated :—

First,—That in none of the specimens were any organic productions present, animalculæ or fungi, either living or dead.

Second,—That in those specimens which were examined very shortly after death, the blood presented its usual structural characters and peculiarities. The red and white corpuscles were of the usual form and size, and presented their ordinary appearances. Occasionally, the red corpuscles were seen to be aggregated into the well-known piles, or rolls, while the white corpuscles were sometimes free and sometimes aggregated, and entangled in meshes of fibrin. This last appearance was presented when the blood had become coagulated, and was attributable to the separation of the fibrin and white corpuscles from the red corpuscles. The same separation occurs in blood after death from other causes than cholera.

Third,—That in some of those specimens of blood which were not examined until some hours after death, changes were observed to have taken place in both the red and white corpuscles. The red corpuscles had become smaller, of unequal size, more globular, and some of them appeared as though they had been in some degree melted down and

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* "On the development of torulæ in the urine, and on the relation of these fungi to albuminous and saccharine urine."—*Medico-chirurgical Transactions*, vol. xxxvi. 1853.

dissolved away. The white corpuscles, at the same time, were not so uniform in size, and were less granular than natural, and there was frequently visible in them one or two shining droplets of fatty matter, a considerable number of free oil globules and a few fibrinous granules were likewise seen floating in the serum. These changes in the condition of the red and white corpuscles were entirely the result of incipient decomposition, and they were not observed in the very recent specimens of the blood, with the exception of a few molecules, and an occasional spherule of oily matter suspended in the serum.

Of the specimens of blood examined, some were obtained from the median cephalic vein, others from the larger internal blood vessels, and some from the cavities of the heart itself. Fibrinous clots or coagula were not unfrequently met with in the latter situation. These exhibited under the microscope all the usual characters of ordinary fibrinous clots, and consisted of fibrillæ of fibrin intermixed with granular matter and the white corpuscles of the blood.

The general result or conclusion to be deduced from these examinations is, that the blood, in cases of death from cholera, does not present any peculiarities discoverable by means of the microscope, its structure being uninjured, and it being entirely free from parasitic developments of every kind.

These observations appear sufficient to disprove two theories which have been entertained with respect to the condition of the blood as a cause of cholera. Thus it has been alleged that the symptoms of cholera were referable to a disintegration or breaking down of the blood corpuscles, and this is one of the theories; while the other theory supposes that cholera arises from the presence of some parasitic production developed in the blood itself, either an animalcule or a fungus.

It is of consequence that these theories, inasmuch as they are incorrect, should be disproved, since the treatment of cholera has not unfrequently been based upon the assumption that one or other of the theories referred to was founded on fact. In proof of this remark, the circumstance of the treatment of cholera by sulphur with the view of destroying any fungus or animalcule which might be present in the blood, may be adduced.

REPORT stating the RESULTS of the MICROSCOPICAL EXAMINATION of the SKIN and CLOTHES of CHOLERA PATIENTS.

So many cases having been reported from time to time of nurses who had been engaged in washing the clothes of cholera patients becoming themselves the subjects of cholera, it was of importance to determine whether the presence of any body or substance could be discovered in the clothes worn during cholera which could explain the communication of the disease.

With this view the following examinations were made:

Portions of the epidermis or skin of six persons who had died of cholera were submitted to the microscope, as well as twelve pieces of

the clothes worn by cholera-patients at the time of decease; some of these being selected in consequence of their being stained with the rice-water evacuations.

Nothing of importance was discovered from the examination of the six portions of epidermis, neither animalcules as vibriones, or sporules or threads of fungi were present in any case.

The pieces of clothes were carefully washed in a little distilled water, and the water itself, as well as any sediment which subsided from it after it had stood for some time, were examined microscopically.

In some cases no solid matter of any kind was to be detected. In other instances vibriones abounded, and were alive and in active motion. The presence of vibriones was sufficiently explained by the fact, that the portions of clothes in these cases were stained with the rice-water discharge, which I have shown in a former report invariably swarms with living vibriones.

In two instances, (and particularly in one case,) in addition to the vibriones, sporules, some of which were germinating, of a species of fungus, were observed. Lastly, in some instances, epithelial scales, derived from the breaking down of the epidermis, were noticed, as also fragments of muscular fibre and vegetable tissue, starchy matter, corpuscles of wheat, together with bright blue particles, probably indigo. The starch and blue discovered was no doubt a portion of that used in the starching and blueing of the clothes examined, while the fragments of striped muscular fibre proceeded from the remnants of food contained in the rice-water discharge.

The only organic productions met with in the examination of the several pieces of linen to which any degree of suspicion is attached are the vibriones, upon which I have already remarked in the report containing the results of observations on the rice-water evacuations of cholera.

If these vibriones possess any influence in the production of cholera, or if the rice-water discharges contain any substance or principle capable of producing that disease, we can readily understand how the washing of the clothes might, in some cases, give rise to cholera in those engaged in washing them.

Report embracing certain Facts relating to the Diffusion of Animalcules and Fungi through the Medium of the Atmosphere, with Remarks concerning the Relation of such Diffusion with the Origin and Propagation of Cholera.

The reproduction of all the smaller and parasitical species of fungi is aerial; that is, they are propagated in contact with the air, and the germs or sporules are so exceedingly small, and are of such extreme lightness, that they are readily and rapidily diffused throughout the atmosphere on the slightest agitation or disturbance; the

atmosphere constitutes, in fact, the natural and ordinary means by which the sporules of this class of productions are diffused, and the propagation of the species ensured.

In the mere fact of the presence in the atmosphere of the sporules of different fungi there is nothing very remarkable, and in establishing the fact of such presence no connexion whatever is proved to exist between these fungi and cholera; indeed, the direct results of all the observations which have been made by means of the microscope into the condition of the solids and fluids of the body in cholera is wholly opposed to the notion that the development of fungi has anything to do with the disease.

It is not only sporules of fungi which are conveyed about in the atmosphere, but many other bodies of great minuteness and trifling weight, as for example, fibres of wool, the starch corpuscles of wheat and other plants; and so commonly are these contained in the atmosphere, that if any fluid be exposed to it for two or three days, these substances will very frequently be found in it on examination with the microscope.

From the fact that the sporules of fungi have been obtained from the emanations of sewers it has been concluded that these sporules were generated in the organic matters contained in them, and that they afterwards became liberated and set free into the air This is, no doubt, the case in some instances; but what I now desire to point out is, that the sporules of fungi thoroughly immersed in fluid cannot be conveyed into the atmosphere by the mere evaporation of the fluid holding them; thus, when the contents of the sewer are fluid and in motion, no diffusion of the sporules can take place; should any sporules, however, float on the surface of the liquid, a few of these might become diffused in the air, carried up by the vapour resulting from evaporation. The accuracy of this statement was proved as follows:—

A sample of urine containing myriads of sporules of the well-known fungus Penicilium glaucum was subjected to slow evaporation or distillation. The urine before distillation was deeply coloured and turbid from the quantity of fungus present, while the distilled liquid was as clear and as bright as water; and on examination of it with the microscope a very few sporules of the fungus were met with only after careful scrutiny. It was apparent to the eye alone that the great bulk of the sporules had been left behind. The very few which passed over were those which rested only on the surface of the urine, and which had not been fairly immersed in it.

The sporules of some species of fungi at a certain stage of their growth repel water and other fluids, so that although they may rest upon it they do not imbibe it, and are really aeriel, resting only on the surface.

We will next bestow a few observations upon vibriones.

First. Vibriones are developed and are to be found in nearly all animal and vegetable infusions which are not too acid (including impure water) at all seasons, and are not peculiar to a period of cholera. This one fact is in itself almost sufficient to prove that there

is no very close or essential connexion between vibriones and cholera. Nevertheless, the invariable presence of vibriones in the rice-water discharges of cholera, even while retained in the system, occasions considerable interest to be attached to these animalcules in relation to cholera. Although not the cause, they may still possibly possess some influence in explaining and aggravating the symptoms.

Next, as to the diffusion of vibriones through the medium of the atmosphere.

Vibriones are true aquatic productions, unlike fungi, which are for the most part aerial, fluids being the media in which, as far as I am aware, they are always developed, and to which they are usually confined; neither can they escape from those fluids and become carried into the atmosphere through the evaporation of the liquids in which they are present. Their incapability of being conveyed into the atmosphere in this way was shown by carefully distilling at a low temperature a portion of rice-water discharge which absolutely teemed with vibriones, and which was opake from the numbers present in it. The fluid distilled off was as clear and transparent as water, and no vibriones were discovered in it on the strictest scrutiny with the microscope; it follows, therefore, that if vibriones are really ever present in the atmosphere they are actually developed in it, and since they require moisture for their development, it must be in some humid condition of the atmosphere that they are thus generated.

Further, the presence of vibriones in the atmosphere implies also the presence of some nitrogenized substance capable of affording nutriment for their support.

It is, therefore, extremely desirable that the fact should be ascertained beyond the possibility of dispute whether vibriones ever float freely in the atmosphere, and, if so, whether their presence is confined to the period of the prevalence of cholera.

Vibriones are so abundantly diffused throughout a great variety of fluids, and they are generated with such extreme rapidity and in such incalculable numbers, that the greatest care is requisite in making observations of this nature.

I will now state the results of an experiment made for the purpose of determining whether anything could be detected in the breath of persons attacked with cholera.

With this view a Wolfe's apparatus was carefully prepared and charged with recently distilled water. Into this several patients labouring under cholera were made to breathe repeatedly for two or three days, at the end of which time the water was observed to be slightly dulled, and in it, after it had been allowed to stand at rest in a conical glass for some hours, numerous sporules of fungi and vibriones were seen, (the vibriones for the most part being developed around fibres of cotton, of which many were present,) a few monads and starch corpuscles of wheat.

On subjecting another portion of the same distilled water, and which had not been previously used in any way, to examination, sporules of the same fungus, and the same species of vibrio and monad were met with, although not in nearly such large numbers as in the water which had been breathed through by cholera patients:

fibres of cotton were also present, as well as starch corpuscles, but the number of these was likewise less.

No production, therefore, was present in the water through which several patients suffering from cholera had been made to respire repeatedly for a period of three days, which was not originally contained in the water used for the experiment. The only apparent effect of the respiration was to hasten and increase the development of the organic matters which were at first contained in the water.

One other experiment, which was made with the hope of throwing further light upon the subject, may here be related. Some water obtained from the artesian well in Piccadilly was submitted to distillation in vessels which had previously been prepared for the purpose, and which had been well washed with concentrated sulphuric acid, to destroy any trace of organic impurity which might accidentally have been present.

With the distilled water thus obtained, which was of very unusual purity, a Wolfe's apparatus, cleansed with the same precautions, was charged. Into this, I myself breathed from time to time, for the space of three days; on the second day the water was observed to have become somewhat dull, and on the third day it was opalescent; examined with the microscope, it was found to abound in large and active animalcules, apparently belonging to the genus Paramesium; no sporules of fungi or vibriones were noticed.

The presence of these animalcules in such large numbers can only be accounted for by supposing that a portion of saliva containing animal matter had made its way, together with the air, down the glass tube which passed into the water, and that this had formed the material or pabulum out of which the animalcules had become developed; but from what source the germs of the animalcules proceeded it is impossible to state.

The above observations on the conveyance of organic productions by means of the atmosphere in connexion with cholera are obviously very incomplete, but at the same time they may furnish some few hints for conducting at a future period similar experiments and observations on a more extended scale.

The general result of these observations, so far as they go, is to prove that the breath of patients labouring under cholera does not contain any organic production which can account for either the origin or propagation of cholera.

Concluding Observations.

The microscopical investigations instituted by me have embraced the Rice-water discharges of Cholera, the Blood, the Urine, the Epidermis or Skin, the Clothes of cholera patients, as well as the Water drank and the Air respired.

The one great result of these investigations is to show that neither in the blood or urine, or on the skin or clothes, or in the water drank, or in the air respired, are any organic productions, either animalculæ or fungi, present, to which the origin or propagation of cholera could be attributed.

The only fluid examined which was found uniformly to contain living organic productions was the rice-water discharge, which even while enclosed in the small intestines swarmed with vibriones.

The presence of these vibriones exhibits at least a remarkable proneness of the contents of the small intestines to undergo rapid decomposition.

In addition to the fluids and articles enumerated above, submitted to microscopical observation, I should mention that I examined portions of the livers and kidneys of two persons who had died of cholera, the mucous membrane of the bronchial tubes, the bile, and the contents of the bladder each in one case. The results were as follow:

One of the portions of liver was light-coloured and fatty-looking, while the other was red and dark-coloured; a few oil globules were found in some of the hepatic cells in both cases, but in larger proportion in the light-coloured piece than in the other; but neither of the livers could be said to be in a state of marked fatty degeneration, and by far the greater number of the secreting cells of these livers were in a state of integrity.

The gall-bladder of one of the livers was half filled with bile of a deep green colour, and having the consistence of treacle; this examined under the microscope was seen to abound in plates of cholesterine.

The microscopical examination of the kidneys did not furnish any particular result.

The epithelium contained in the mucus of the bronchial tubes was in a state of apparent integrity, but the fluid part of the mucus abounded in vibriones; the presence of these was, no doubt, due to incipient decomposition, although this decomposition was not appreciable either by the appearance presented by the mucous membrane or by its smell. There were also observed a considerable number of oil globules of all sizes, and large round corpuscular-looking bodies, perfectly free from granulation, and resembling closely the vesicular corpuscles of the white substance of the brain.

The bladder examined was exceedingly small and contracted, and on opening it there was present in it about a dessert-spoonful of a yellow, cream-like, and purulent-looking substance; this viewed under the microscope was found to consist chiefly of mucus and scales of vesical epithelium, no vibriones being present; their absence was sufficiently explained by the strong acid reaction exhibited by the mucus.

Arthur Hill Hassall, M.D.

Bennett Street, 22d January 1855.

No. XII.

Tables from a Report of the Middlesex Hospital, illustrating the relation of Consecutive Fever to the Collapse and Discharges of Cholera.

TABLE A.

TABLE of those CASES in which the CONSECUTIVE FEVER was SLIGHT or TRIVIAL.

MALES.

No.	Hours in Collapse.	Intensity of Collapse.	Amount of Purging.	Result.
15	30	Extreme -	Profuse -	Death from collapse.
23	48	" -	Considerable -	Recovery.
30	15	" -	" -	"
32	78	Complete -	Profuse -	"
41	9	" -	Considerable -	"
50	18	" -	Profuse -	"
51	83	" -	" -	"
55	—	Incomplete -	" -	"
58	49	Complete -	Considerable -	"
60	28	Extreme -	Profuse -	"
78	28	Complete -	" -	"
85	19	Incomplete -	Moderate -	"
98	10	" -	Slight -	"
101	20	" -	Moderate -	"
121	27	Complete -	Profuse -	"

FEMALES.

No.	Hours in Collapse.	Intensity of Collapse.	Amount of Purging.	Result.
127	47	Extreme -	Considerable -	Recovery.
130	11	Complete -	Profuse -	"
132	12 (?)	" -	" -	Death from maennia.
137	34	" -	Moderate -	Recovery.
148	42	" -	Considerable -	"
151	16	Complete -	Slight -	"
153	28	" -	Considerable -	Death from relapse.
156	13	" -	" -	Recovery.
158	3	" -	Profuse -	"
161	9	Incomplete -	Considerable -	"
168	12	Complete -	Profuse -	"
170	17	Incomplete -	" -	"
175	28	" -	" -	"
186	25	" -	Slight -	"

TABLE A.—*continued.*

FEMALES—*continued.*

No.	Hours in Collapse.	Intensity of Collapse.	Amount of Purging.	Result.
187	32	Incomplete -	Profuse -	Recovery.
196	45	Complete -	Considerable -	,,
—	12	Incomplete -	Slight -	,,
203	8	,, -	Moderate -	,,
204	53	Extreme -	Profuse -	,,
206	46	,, -	Slight -	Death from relapse.
214	12	Complete -	,, -	Recovery.
215	18	Slight -	Considerable -	,,
217	10	Extreme -	Moderate -	,,
221	24	,, -	Profuse -	,,
230	12	Complete -	Considerable -	,,
231	6	,, -	Profuse -	,,

TABLE B.

TABLE of those CASES in which the CONSECUTIVE FEVER was either WELL MARKED or SEVERE.

MALES.

No.	Hours in Collapse.	Intensity of Collapse.	Amount of Purging.	Result.
26	53	Extreme -	Profuse -	Death.
36	31	,, -	Severe -	,,
39	26	Considerable -	Profuse -	Recovery.
47	79	Extreme -	Moderate -	,,
62	82	Complete -	Profuse -	,,
63	50	,, -	,, -	,,
69	72	,, -	,, -	,,
70	72	Extreme -	,, -	,,
74	48	Complete -	Moderate -	Death from epilepsy.
77	36	Extreme -	Profuse -	Death from maennia.
31	58	Complete -	Considerable -	Recovery.
95	19	Incomplete -	Slight -	Death from epilepsy.
97	12	Complete -	,, -	Death.
112	68	,, -	Profuse -	Recovery.
116	26	Incomplete -	Slight -	,,

TABLE B.—*continued.*

FEMALES.

No.	Hours in Collapse.	Intensity of Collapse.	Amount of Purging.	Result.
131	48 (?)	Complete -	Profuse -	Death.
133	30	Extreme -	" -	Recovery.
136	39	Complete -	Considerable -	"
139	24	Extreme -	Profuse -	"
154	11	" -	Considerable -	"
155	11	" -	" -	"
169	60 (?)	Extreme -	Profuse -	"
173	50	Complete -	" -	Death.
177	29	" -	Moderate -	Recovery.
181	72	Extreme -	Severe -	Death.
175	30	" -	Profuse -	Recovery.

No. XIII.

Account of Twelve Post-mortem Examinations, made at St. Bartholomew's Hospital. By G. W. Callender, Registrar and Demonstrator of Morbid Anatomy at the Hospital.

No.	Sex. Age.	Disease.	Date of Death.	When examined.	—
1	T. N. male, 48.	Cholera, collapse, 16 hours.	1854. Sept. 15, 4 a.m.	Hours after death, 29. Mean temp. 61·0.	Residence, Bishopsgate; in destitute circumstances, attacked in common with the other inhabitants of the house. Health previously good.
2	— S. male, 56.	Cholera, collapse, about 20 hours.	Sept. 17, 7.30 p.m.	Hours after death, 16½. Mean temp. 63·0.	Picked up in the streets.
3	E. G. female, 10½.	Cholera, collapse, 23 hours.	Oct. 17, 11.15 a.m.	Hours after death, 23½. Mean temp. 44·0	Residence, Milton Street; circumstances, good. No one at the time affected in her neighbourhood. Health previously unaffected.
4	M. H. female, 39, married.	Cholera, collapse, 32 hours.	Oct. 8, 7.20 a.m.	Hours after death, 28½. Mean temp. 54·4.	Circumstances comfortable. Health previously good.
5	J. B. female, 25, married.	Cholera, collapse, 44 hours.	Oct. 8, 4 p.m.	Hours after death, 23. Mean temp. 54·4.	Circumstances comfortable. Health previously good.
6	W. T. male, 34.	Cholera, collapse, gradual sinking, 72 hours.	Sept. 26, 9.30 a.m.	Hours after death, 18½. Mean temp. 53·0.	Circumstances good. In perfect health before this attack, the night preceding which he passed in his barge opposite the debouchement of the Fleet Ditch, near Blackfriars Bridge.
7	M. G. female, 62, spinster.	Cholera, collapse, gradual sinking, 87 hours.	Sept. 26, 10 p.m.	Hours after death, 14. Mean temp. 53·0.	In good health, and easy circumstances, prior to the attack.
8	W. K. male, 37.	Cholera, collapse, partial reaction, gradual sinking, 128 hours.	Sept. 28, 8 p.m.	Hours after death, 16. Mean temp. 56·4.	In indigent circumstances, but free from actual illness.
9	M. A. S. female, 44, married.	Cholera, collapse, reaction, rapid sinking, 144 hours.	Sept. 9, 7 a.m.	Hours after death, 8. Mean temp. 54·2.	In indigent circumstances; had been ailing for more than a month with diarrhœa, and occasional vomiting.
10	F. F. male, 4½.	Cholera, collapse, reaction, stupor, rapid sinking, with dyspnœa, 192 hours.	Sept. 12, 11 a.m.	Hours after death, 25. Mean temp. 62·3.	Brought from a house where others were similarly affected; previously in good health.
11	C. R. male, 32.	Cholera, collapse, reaction, gradual sinking, 240 hours.	Sept. 11, 2 a.m.	Hours after death, 13. Mean temp. 55·6.	In good circumstances; previously healthy.
12	W. B. male, 21.	Cholera, collapse, reaction, stupor, dyspnœa, gradual sinking, 304 hours.	Sept. 15, 4 p.m.	Hours after death, 19½. Mean temp. 61·0.	In good circumstances; previously healthy, but an inmate of a lunatic asylum.

No.	Heat.	General Condition.	Muscular and other Tissues.	Eyes.	Rigidity.
1	Absent -	Integument pale, except in the dependent parts; fingers livid, shrivelled, contracted upon the palms; body well nourished.	Muscles natural; adipose tissue scanty.	Sunken in their sockets.	Well marked in the extremities and on the left side of the heart.
2	Absent -	Robust; integument livid - -	Muscles dark; adipose tissue abundant.	Sunken in their sockets.	Marked in the lower extremities and left side of the heart.
3	Surface cool; thoracic and abdominal cavities warm.	Well nourished; integument pale.	Muscles natural.	Sunken in their sockets.	Marked in the lower extremities and left side of the heart.
4	Absent -	Well nourished; integument pale.	Muscles natural; adipose tissue abundant.	Sunken in their sockets.	Marked in the lower extremities and left side of the heart.
5	Absent -	Emaciated; integument shrivelled and inelastic; fingers livid, contracted upon the palms.	Muscles natural.	Sunken in their sockets.	Well marked, save on the right side of the heart.
6	Absent -	Well nourished; integument covered with a dusky mottling; fingers contracted; lips livid.	Muscles dark.	Sunken in their sockets.	Well marked, save on the right side of the heart.
7	Absent -	Well nourished; integument pale; fingers contracted; lips livid.	Muscles natural; adipose tissue abundant.	Sunken in their sockets.	Marked in the extremities and left side of the heart.
8	Absent -	Well nourished; integument pale; fingers shrivelled, contracted.	Muscles natural; adipose tissue abundant.	Deeply sunken in their sockets.	Well marked, save on the right side of the heart.
9	Absent -	Emaciated; integument pale, inelastic, pitting on pressure; fingers shrivelled, contracted upon the palms.	Muscles natural.	- - -	Strongly marked, save on the right side of heart.
10	Absent -	Well nourished; integument pale; lips livid; prepuce and glans penis of a black colour, moist and fœtid; fingers shrivelled, contracted.	Muscles natural; adipose tissue abundant.	Sunken in their sockets, surrounded by a dark areola, several layers of cornea, with its conjunctional covering, absent from both.	Marked in the lower extremities and left side of the heart.
11	Absent -	Well nourished; integument mottled about the chest and abdomen; lips livid; shoulders and neck covered with white spots (caused by a slight elevation of the epidermis by purulent fluid) surrounded by a livid congestion; prepuce and glans penis black, fœtid, rapidly decomposing.	Muscles dark, dry, and sticky.	Sunken in their sockets, and surrounded by a dark areola.	Remarkable throughout the body, with the exception of the heart, which was everywhere flabby.
12	Absent -	Much emaciated; integument pale; lips livid; prepuce and glans penis black, fœtid; fingers livid, shrivelled, contracted on the palms.	Muscles dark; adipose tissue very scanty.	Sunken in their sockets; cornea softened, opaque, easily scraped off with the handle of the knife.	Remarkable throughout the body, with the exception of the right side of the heart.

The SKULL and its CONTENTS.

No.	Membranes.	Sinuses.	Arteries.	Ventricles.	Brain, &c.
1	Not examined.				
2	Not examined.				
3	Not examined.				
4	Natural - -	Contained small separated clots.	Natural - -	Contained a little clear fluid.	Natural.
5	Natural - -	Contained many small, soft, separated clots.	Natural - -	Contained a small quantity of clear fluid.	Natural.
6	Natural - -	Contained small separated clots.	Natural - -	Contained a little clear fluid.	Natural.
7	Natural - -	Contained dark blood with soft coloured clots.	Occupied by extensive atheromatous deposits.	Contained a very small quantity of clear fluid.	Natural.
8	Natural - -	Contained small separated clots.	Natural - -	Contained a little clear fluid.	Natural.
9	Vessels remarkably free from blood. Choroid plexuses pale.	Contained dark fluid blood with soft coloured clots.	Natural - -	Contained a little clear fluid.	Natural.
10	Not examined.				
11	Natural - -	Contained dark fluid blood.	Natural - -	Contained clear fluid.	Natural.
12	Arachnoid opaque thick, with clear fluid in excess in the subarachnoid spaces.	Contained soft separated clots and fluid blood.	Natural - -	Contained clear fluid in excess.	Natural.

The HEART and BLOOD VESSELS.

No.	Pericardium.	Heart.*	Blood Vessels.
1	Contained from ʒj to ʒij of clear serum.	Weight, 8 oz. 6 drs. Right side flaccid, the cavities containing soft separated clots; left side firmly contracted, the cavities containing a few shreds of fibrine.	Venæ cavæ full of dark fluid blood, in which floated a few soft coloured clots. Aorta occupied by a firm fibrinous coagulum.
2	Moistened by the usual serous fluid; opaque and thickened in patches over the right ventricle anteriorly.	Weight, 8 oz. 3 drs. Right side flaccid, cavities filled with dark-coloured clots; left side firmly contracted; extensive ecchymoses beneath the pericardium, covering the right ventricle anteriorly and posteriorly.	Large venous trunks filled with dark thick blood, fluid, or forming soft clots. Vena azygos similarly distended. Veins and arteries examined as far as the popliteal and found natural in appearance.
3	Surface slimy.	Right side flaccid, cavities filled with firm separated clots; left side firmly contracted; extensive ecchymoses beneath the pericardium, covering the right ventricle posteriorly.	Venæ cavæ contained fluid blood. Aorta and pulmonary artery occupied by firm separated clots.
4	Slight opacity and thickening in patches; surface moist; ecchymoses about the roots of the arteries, and on the posterior surface of the right ventricle.	Weight, 7 oz. 4 drs. Right side flaccid, cavities occupied by firm separated clots; left side contracted.	As above.
5	Just moistened by a viscid fluid; when smeared over the fingers, this drew out in fine threads on separating them from one another.	Weight, 7 oz. 3 drs. Right side flaccid, cavities filled with firm separated clots; left side firmly contracted, cavities contained shreds of blood-stained fibrine.	Venæ cavæ and pulmonary veins occupied by dark fluid blood; aorta and pulmonary artery by firm separated clots.
6	Surface slimy; opaque, and thickened in patches on the anterior surface of the right ventricle.	Weight 8 oz. 3 drs. Right side flaccid; auricle occupied by a tough separated clot, which extended into and filled the ventricle along the auricular surface of the tricuspid; left side firmly contracted; numerous ecchymoses beneath the pericardium on the posterior surface of the right ventricle.	Venæ cavæ full of dark fluid blood. Aorta and pulmonary artery occupied by tough separated coagula.
7	Contained just enough slimy fluid to moisten its surface.	Weight, 8 oz. 2 drs. Right side flaccid, auricle occupied by a clot similar to that in case 6; left side firmly contracted, an opaque thickened patch of pericardium on anterior surface of right ventricle; numerous ecchymoses posteriorly.	Venæ cavæ occupied by dark fluid blood. Aorta and pulmonary artery by firm separated clots. Atheromatous deposits in all the large arterial trunks.
8	Contained a small quantity of yellowish fluid not particularly viscid.	Weight, 7 oz. 6. drs. Right side flabby, cavities occupied by numerous firm separated clots; left side firmly contracted; posterior wall of right ventricle marked by many ecchymoses, especially along the track of the blood vessels.	
9	Contained about ʒss. of slimy fluid, not unlike ordinary synovia.	Weight, 7 oz. Right side flaccid, cavities filled with dark coagulated blood; left side firmly contracted; endocardium lining the auricle, opaque, thick, and rough.	The vena cava superior and the vessels uniting to form it were occupied by a continuous clot of separated fibrine. The pulmonary veins contained soft dark clots, the aorta, pulmonary artery, and cava inferior dark fluid blood. Arteries atheromatous.
10	Contained a small quantity of clear yellowish fluid.	Weight, 2 oz. 2 drs. Right side flaccid, cavities contained firm separated clots; left side contracted, cavities contained a few shreds of fibrine. Endocardium, pulmonary artery, and aorta blood-stained.	The vena cava superior contained blood coagulated and separated. The inferior cava, the aorta, and pulmonary artery contained fluid blood with soft clots.
11	Surface slimy, contained about ʒss. of a viscid fluid.	Weight, 8 oz. 2 drs. Everywhere soft and flabby; right cavities contained fluid blood and soft clots.	Veins and arteries contained fluid blood.
12	Surface natural, contained a few drops of yellowish fluid.	Weight, 9 oz. Right side flaccid, cavities contained firm separated clots; left side contracted, auricle contained a large firm separated clot.	Vena cava and aorta full of soft clots and fluid blood.

* Weighed empty; vessels cut short. Valves healthy in every case.

The Blood.

No.	Colour, fluidity, oxydising, and coagula.	Hours after Death.	——
1	Dark; coagula scanty, soft, coloured -	29	Right cavities of the heart, pulmonary artery, and principal venous trunks * gorged with blood. Portal veins almost empty. Small quantity in aorta.
2	Dark; less fluid than natural; oxydising slowly; coagula scanty, soft, coloured.	16½	As above.
3	Natural in appearance; coagula firm, separated.	23½	As above.
4	Natural in appearance; coagula firm, separated.	28½	As above.
5	Dark; less fluid than natural; oxydising slowly; coagula firm, separated.†	23	As above, save that more blood was present in the portal veins.†
6	Dark; less fluid than natural; coagula separated, firm.	18½	As above.
7	Natural; coagula firm, separated - -	14	As above.
8	Natural; coagula firm, separated - -	16	As above.
9	Oxydising slowly; coagula soft, coloured; separated in the vena cava superior only.	8	As above, save that more blood was present in the portal veins.
10	Natural; coagula soft, coloured; separated in the right cavities of the heart and cava superior only.	25	As above.
11	Fluid, with soft coloured coagula - -	13	As above, save that the portal veins were full of blood.
12	Natural; coagula separated - - -	19½	As above.‡

The Capillaries.

1	Bronchi and lungs congested; intestines, mucous membrane pale; liver pale.	7	Slight congestion of mucous membrane of the stomach; punctate congestion of small, congestion and ecchymosis of large, intestines; liver pale.
2	Lungs congested; punctate congestion of mucous membrane of the stomach; liver pale; kidneys congested.	8	Trachea and bronchi congested; kidneys pale.
3	Punctate congestion of the mucous membrane of the stomach; congestion around Peyer's patches; stellate congestion of large intestine; liver pale; kidneys pale.	9	Congestion and ecchymosis of mucous membrane of the stomach; ecchymosis and congestion of small, congestion and ecchymosis of large, intestine; liver pale; kidneys pale.
4	Punctate congestion of mucous membrane of the stomach, elsewhere mucous membrane pale; liver pale; kidneys pale.	10	Bronchi congested; pneumonia; ecchymosis of mucous membrane of the stomach; mucous membrane of intestine pale; liver pale; kidneys pale.
5	Bronchi congested; mucous membrane of small intestine congested; liver pale.	11	Congestion and ecchymosis of mucous membrane of the stomach and small intestine; kidneys pale.
6	Bronchi congested; punctate congestion of the small intestine; congestion of mucous membrane of large intestine; kidneys pale.	12	All the respiratory and intestinal tracts of mucous membrane intensely congested; pneumonia; ecchymosis about the duodenum on its mucous surface.

* The *venous trunks*, viz., the pulmonary veins, venæ cavæ, and principal branches, vena azygos, and costal veins.

† *Small flakes*, like the dregs of port wine, floated in the blood contained in the portal veins, consisting of corpuscles (coloured) packed together so as to resemble a tesselated pavement. This condition was noticed in the blood of the case generally, and was not confined to the portal circulation.—Examined 23 hours after *death*.

‡ The *blood* present in the liver was contained almost entirely by the hepatic veins, and was invariably fluid.

The *Microscope* did not reveal any peculiarity in the condition of the blood, save indeed that in no instance was the tendency to adhere together in little piles exhibited by the blood disks.

Ecchymosis of the subserous tissue was observed in six cases, viz. in those numbered 2, 3, 4, 6, 7, 8.

Ecchymosis of the submucous tissue was observed in five cases, viz., in the stomach 9, 10, 11; n the small intestine 9, 11, 12; in the large intestine 7, 9.

Respiratory Organs.

No.	Pleuræ.	Larynx, Trachea, Bronchi.	Lungs.
1	Contained about ℥ ss. of brownish fluid (blood-stained); surface natural to the touch.	The mucous surface of the bronchi slightly reddened.	Rather œdematous in both lower lobes.
2	Occupied by old (tough) adhesions; costal surfaces considerably ecchymosed, the seat of the extravasation being the subserous tissue.	Natural in appearance -	Of a bright red colour; the lower lobe on the left side floated deeply in water, was of a dark red colour, scarcely any air issuing from its cut surface. No softening.
3	Surfaces moistened through a scanty viscid secretion.	The mucous surface of the bronchi of a bright red colour.	Of a bright red colour in the lower lobes.
4	Natural, moistened by a little fluid.	Natural in appearance -	Natural in appearance.
5	Surfaces just moistened by a scanty viscid fluid, costal surfaces considerably ecchymosed posteriorly, especially by the side of the vertebræ.	The mucous membrane lining the larynx, trachea, and bronchi, of a bright red colour.	Pale, containing apparently but little blood.
6	Occupied by old (tough) adhesions; surfaces, where free, just moistened by a viscid fluid, costal surfaces much ecchymosed.	The mucous membrane lining the bronchi slightly reddened.	Natural.
7	Right pleura occupied by many thick layers of dense fibro-cellular tissue compressing the lung; left moistened by a little slimy fluid.	Natural in appearance.	Right carnified, closely bound down by the false membranes of the pleura; left rather œdematous.
8	Contained yellowish serum, with old adhesions about either apex.	Mucous membrane lining the trachea of deep red colour, that lining the bronchi of a deeper red, and swollen.	Slightly œdematous.
9	Surfaces slimy, old adhesions about either apex.	Natural in appearance -	Lungs occupied by a few cretified tubercles; otherwise natural.
10	Surfaces slimy - - - -	Mucous membrane lining the bronchi, reddened, swollen, covered with an abundance of viscid mucus.	Left lung: lower lobe of a deep red colour, solid, softened, floating deeply in water; upper lobe œdematous. Right lung of a deep red colour, here and there solid, such portions floating deeply; upper lobe natural.
11	Surfaces just moistened by a viscid fluid.	Natural in appearance -	Emphysematous.
12	Surfaces just moistened by a viscid fluid.	Larynx and trachea natural. Bronchi, mucous lining of a deep red colour, swollen, covered with a copious mucopurulent secretion, even to the smallest branches. *Note.*—Bronchial glands natural in every case.	Left lung: on this side were several lobules solid, softened, sinking in water, of a greyish colour, a dirty purulent fluid exuding on pressure. Around them the pulmonary tissue was of a natural appearance, except where pus escaped from the divided bronchi. The right lung resembled the left.

Digestive Organs, &c.

No.	Peritoneum.	Æsophagus.	Stomach.
1	Natural, its sac moistened by clear fluid.	Cardiac extremity of a deep red colour; mucous follicles enlarged and of a milk-white colour.	Natural; contents, coagulated milk, with tenacious mucus.
2	Natural - - - -	Natural - - - -	Marked irregularly over its mucous surface with patches of punctate congestion. Contents thick grumous fluid, and a great quantity of gas.
3	Surface slimy - -	Natural - - - -	Contracted: punctate congestion in patches along the greater curvature. Mucous membrane softened. Contents, grumous greenish black fluid.
4	Surface slimy, where covering the transverse colon discoloured in spots from extravasations of blood.	Cardiac extremity of a deep red colour.	Contracted; punctate congestion about the cardiac extremity, and the great cul de sac.
5	Surface sticky, ecchymoses over the colon in all its divisions.	Slight reddening of its cardiac extremity.	Natural.
6	Surface sticky, numerous ecchymoses opposite to the mesentery.	Mucous membrane pale -	Mucous membrane pale.
7	Natural - - - -	Mucous membrane pale -	Moderately distended with air and tenacious brownish fluid. Mucous membrane pale, covered with tenacious mucus.
8	Natural - - - -	Mucous membrane pale -	Slightly congested about the greater curvature.
9	Surface slimy - -	Natural - - - -	Very much contracted, its mucous surface thrown into folds, and congested about the greater curvature; contents, frothy tenacious fluid, mixed with mucus, and stained of a greenish colour. About the middle of the curvature were several apparently irregularly shaped ecchymoses, from the size of a millet seed downwards. The blood was easily removed, and was then seen to be lodged in a small excavation of the mucous membrane, at the bottom of which the submucous tissue was exposed, a small vascular point occupying the centre of the shallow ulcer.
10	Natural - - - -	Mucous membrane pale -	Mucous membrane pale, thickly covered with tenacious mucus of a greenish colour. A few ecchymosed spots were sprinkled over the greater curvature.
11	Surface sticky; old adhesions between several of the convolutions.	Natural - - - -	Mucous surface of a deep red colour, with numerous ecchymoses towards its cardiac extremity. Cavity distended with gas and viscid yellow mucus.
12	- - - - -	Covered as to its mucous surface, with shallow, ragged ulcers of uncertain size, arranged longitudinally, penetrating to the submucous tissue, their edges of a bright red colour.	Mucous surface of a deep chocolate colour, the membrane being soft and easily torn off. Contents, dark grumous fluid, mixed with ingesta.

Small Intestine.

No.	Contents.	Mucous Membrane.	Villi.	Glands.
1	Gruel-like fluid and gas, distending the canal.	Pale soft, easily separated from the subjacent tissue.	Prominent, and in many parts raised with the mucous membrane from the subjacent tissue by gas. Denuded of epithelium, they contained granular and fatty matter, which gave them the greyish colour noticed by the unaided eye.	Peyer's patches and solitary glands greatly enlarged, of a milk-white colour, especially about the extremity of the ileum; contents, a fluid laden with granules and fat.
2	Gruel-like fluid; no trace of oil, this man having taken much, and retained some of the oleum ricini.	Soft, and affected by post-mortem changes. Everywhere deeply stained from the escape of the colouring matter of the blood.		
3	Gruel-like fluid, in which were many dark masses, consisting almost entirely of blood disks.	Of a deep red colour around Peyer's patches.*	Opaque and prominent.	* See before.
4	Gruel or rice-water-like fluid.	Pale, dotted over with opaque specks.	Opaque and prominent.	Natural.
5	Thin gruel-like fluid	Generally pale, but here and there the seat of slight punctate congestion.	Prominent, opaque, deprived of the epithelium, laden with nebulous matter consisting of granules and fat.	Natural.
6	Grumous blood-stained fluid.	Mucous membrane everywhere of a deep red colour (especially in the lower part of the gut surrounding Peyer's patches), much swollen, and quite overlapping the glands.	Of a deep red colour	Pale as contrasted with the surrounding mucus membrane.
7	Thick tenacious mucus.	Mucous membrane pale, with patches of punctate congestion.	Prominent & opaque, devoid of epithelium, with the above-mentioned granular and fatty contents; vessels distended with blood.	Natural.
8	Greyish tenacious mucus.	Mucous membrane pale - -	Natural - - -	Natural.
9	Gas, and a brownish red fluid mixed with mucus.	Mucous membrane congested in irregularly-seated patches with numerous small ecchymoses, the blood being easily washed away with water. About 3 feet above the commencement of the jejunum several excavations resembling those in the stomach were found on the rugæ opposite to the mesentery.	Natural - - -	Natural.
10	Bile-stained - -	Mucous membrane pale, dotted over with white specks. Canal contracted, with an intus-susception 5 feet below the duodenum, the tissue around it being pallid.	Prominent, opaque, denuded of epithelium, laden with granular matter and fat.	Natural.
11	Bile-stained tenacious fluid.	Mucous membrane of a deep red colour, here and there ecchy-mosed.	Natural - - -	Solitary glands enlarged, of a milky-white colour.
12	Below, grumous blood-stained fluid, distending the canal; bile-stained feces above.	Mucous membrano in the lower third intensely congested, of a deep chocolate colour. Above, the congestion was less marked, but in the duodenum it became again intense, with slight ecchymoses.	Congested - -	Natural.

Large Intestine, &c.

No.	Large Intestine.	Mesentery.	Absorbents.
1	Distended with gruel-like fluid; mucous membrane soft, pale; solitary glands enlarged, of a milky white colour.	Veins full of dark blood; glands natural.	Thoracic duct empty; chyle in the lacteals.
2	Contained a grumous fluid of a greyish colour; mucous membrane pale; glands natural.	Glands enlarged, and vascular in excess; veins full of dark blood.	Thoracic duct empty.
3	Contents as in the small; mucous membrane pale, with occasional stellate congestion.	Glands enlarged of a pale yellow colour.	
4	Contents as in the small intestine; mucous membrane pale; glands natural.	Veins full of dark blood; glands natural.	
5	Contents thin gruel-like fluid; mucous membrane natural.	Veins laden with dark fluid blood.	Thoracic duct empty.
6	Contents grumous blood-stained fluid; mucous membrane congested; solitary glands enlarged, and the orifices of the tubuli surrounding them unusually distinct.	Glands slightly enlarged, pale and sodden; veins full of dark fluid blood.	
7	Contents powdery and bile-stained; mucous membrane of the sigmoid flexure and rectum congested with numerous ecchymoses; glands natural.	Laden with a superabundance of fat.	Thoracic duct empty.
8	Contents bile-stained feces; mucous membrane pale.	Natural.	
9	Contents red-stained grumous fluid; mucous membrane congested about the colon with many small ecchymoses.	Glands occupied by calcareous deposits; veins full of dark fluid blood.	
10	Contents bile-stained feces; mucous membrane natural.	Glands slightly enlarged; veins full of dark fluid blood.	Thoracic duct empty.
11	Distended with a reddish grumous fluid; mucous membrane deeply congested, and marked along the muscular band opposite to the attached surface by numerous shallow excavations of the mucous membrane, irregular as to shape, following a longitudinal direction.	Veins full of dark fluid blood.	Thoracic duct empty.
12	Contents flatus and bile-stained feces; mucous membrane congested, especially in the rectum.	Glands large, and vascular in excess; veins full of dark fluid blood.	Thoracic duct empty; the lacteals contained some chyle.

GLANDS, &c.

No.	Liver.	Gall Bladder.	Pancreas.	Spleen.
1	Weight, 30 oz. 6 drs.; pale, no bile in the ducts.	Weight, with contents, 7 drs.; filled with dark brownish bile, easily pressed into the duodenum.	(In every case the pancreas presented a natural appearance.)	Weight, 3 oz. 6 drs. Natural.
2	Weight, 45 oz. 6 drs.; pale and sodden; no bile in the ducts, and scarcely any blood to be pressed from its cut surface.	Weight, with contents, 1 oz. 5 drs.; filled with dark green ropy bile.	- - -	Natural.
3	Weight, * * * * pale	Distended with dark greenish bile.	- - -	Small, firm.
4	Weight, 42 oz. 7 drs.; pale, scarcely any blood escaping from its cut surface.	Contracted; contents thick green-coloured bile.	- - -	Weight, 5 oz. 3 drs. Firm and dark.
5	Weight, 38 oz. 6 drs.; pale and sodden; no bile exuding from the ducts on its cut surface. Blood in the portal veins dark, with small flakes, like wine dregs, floating in it. These consisted of closely packed blood disks adhering by their edges.	Contained 2 oz. of thick, ropy, greenish bile.	- - -	Weight, 4 oz. 3 drs. Firm and dark.
6	Weight, 53 oz. Blood flowed freely from the cut surface, and a little thick bile occupied the larger bile ducts.	Distended with dark ropy bile, deeply staining the lining membrane.	- - -	Large, soft.
7	Weight, 38 oz; pale, a little blood escaping from the hepatic veins on its cut surface.	Contained 2 ozs. of thick greenish bile, deeply staining its mucous lining.	- - -	Small and firm.
8	Weight, 46 oz. 3 drs.; natural -	Distended, with tenacious greenish bile.	- - -	Small and firm, of a deep red colour.
9	Weight, 29 oz.; pale, the portal veins contained a little dark fluid blood.	Contained 1 oz. 4 drs. of dark (not thick) greenish bile, which passed readily, on pressure, into the duodenum.	- - -	Weight, 3 oz. 6 drs. Dark, firm.
10	Weight, 16 oz. 6 drs.; pale and sodden. Hepatic cells laden with granular fat and oil globules.	Contained rather more than 1 oz. of thin limpid fluid, in which floated numerous yellowish flakes. Mucous membrane pale.	- - -	Natural.
11	Weight, 48 oz.; natural. Portal veins laden with dark thick blood.	Contained 3 oz. of black bile, the consistence of pitch, deeply staining the mucous walls; it however readily passed, on pressure, into the duodenum.	- - -	Natural.
12	Weight, 54 oz. 4 drs.; natural -	Contained a very small quantity of thick yellowish bile, which passed readily into the duodenum.	- - -	Natural. Weight, 6 oz. 4 drs.

Urinary Organs, &c.

No.	Kidneys.	Ureters.	Bladder.	Uterus, &c.
1	Natural in appearance [illegible] left [illegible] oz.; right [illegible]	Natural in every case.	Contracted, empty, mucous lining natural.	
2	Slightly con[illegible]; weight [illegible] left, [illegible] drs.; right, [illegible] oz. 2 drs.	- -	Contracted, empty, mucous lining natural.	
3	Pale with patches, on their surface, [illegible] congestion; the calices contained inspissated urine.	- -	Contracted, empty, mucous lining natural.	Ovaries, covered with a thick and opaque capsule, contained numerous Graafian vesicles; uterus natural.
[illegible]	[illegible] —left, [illegible] oz. 6 drs.; [illegible]	- -	Contracted, empty -	Uterus and its appendages natural.
[illegible]	[illegible]rwise natural; the [illegible]tained thick urine.	- -	Contracted, empty, mucous lining natural.	Uterus and its appendages natural.
6	Natural - - - - -	- -	Contracted, empty, mucous lining natural.	
7	Capsule on the right side thickened, and small cysts present in the cortical layer; left natural; weight—left, 4 oz. 6 drs.; right, 3 oz. 2 drs.	- -	Contracted, empty, mucous lining natural.	Uterus and its appendages natural.
8	Pale - - - - - -	- -	Contracted, empty, mucous lining natural.	
9	Left pale; capsule adherent; right less pale, with a small cyst in its cortical layer; weight—left, 4 oz. 6 drs.; right, 4 oz. 5 drs.	- -	Contained ℥ iv. of clear alkaline urine microscopic appearance influenced by decomposition.	Uterus natural; Fallopian tubes surrounded by numerous small cysts containing a clear albuminous fluid.
10	Left pale; right less so; calices contained inspissated urine; weight—left, 2 oz.; right, 1 oz. 7 drs.	- -	Distended with clear urine; mucous lining natural, microscopic examination influenced as above.	
[illegible]	Pal[illegible] otherwise natural - -	- -	Contracted, empty, mucous lining natural.	
[illegible]	Natural - - - - -	- -	Contracted, empty, mucous lining natural.	

X

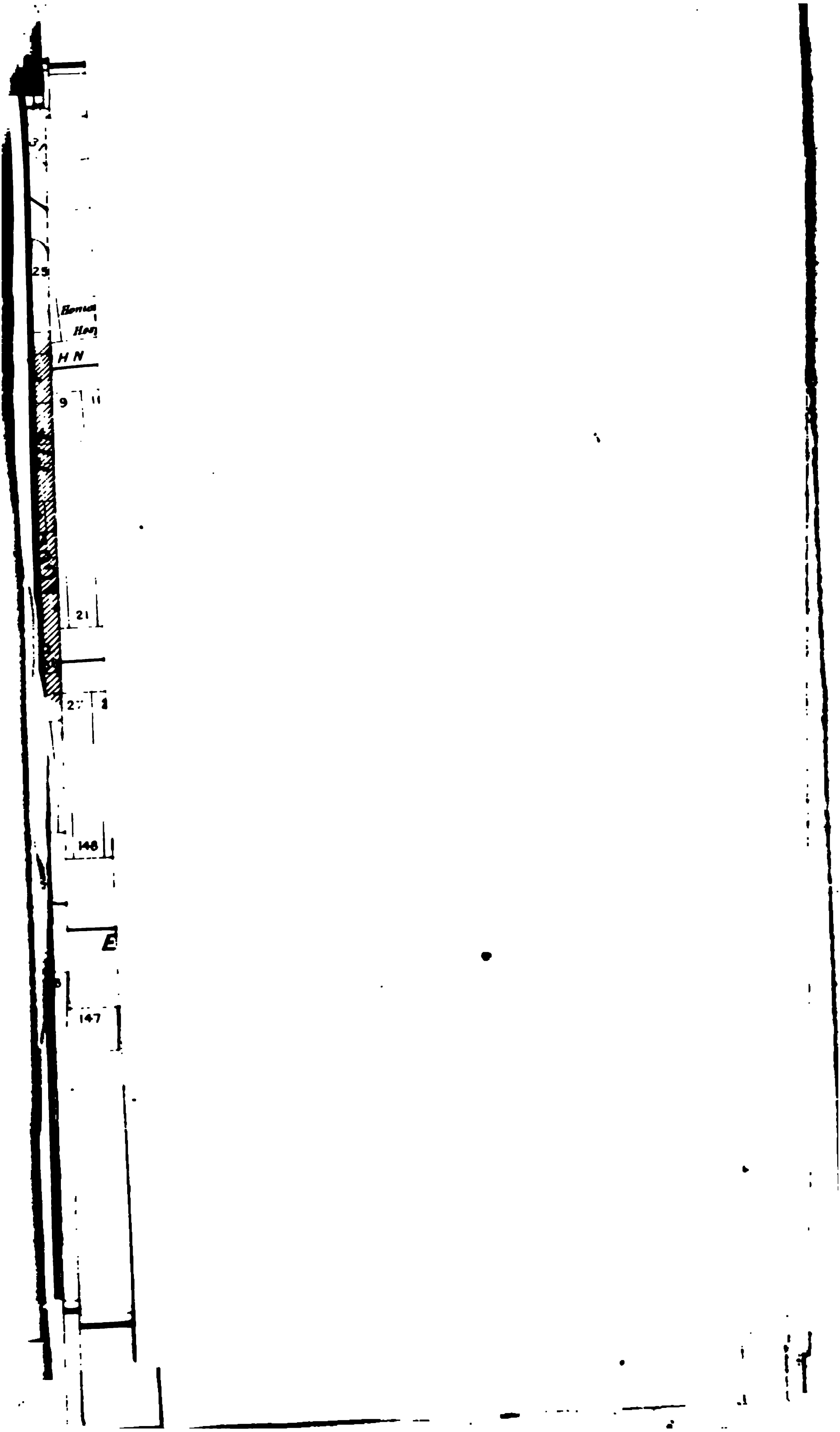
No. XIV.

The following Schedules are the result of inquiries made on the spot and at the six nearest hospitals, and the workhouses of St. James's and St. Anne's, beginning with the 5th September. Many of the results must necessarily be only proximately correct, amongst other reasons, from the great difficulty of obtaining accurate information from the inmates, a difficulty which went on increasing in proportion as the date of the actual outbreak receded. This was sometimes the effect of unavoidable physical causes, such as the removal from the premises of every person qualified to supply the requisite facts; in other cases, no doubt of the unskilfulness of the questioner; in very many, from a reluctance of the parties questioned to tell all the truth, either from a personal interest as landlords leading them to fear any depreciation in the value of their property, or from the like personal interest as tenants leading them to shrink from offending their landlords; and lastly, from an almost general inability on the part of the residents to attach any importance to deaths occurring off the premises. Thus, although latterly we invariably explained in inquiring as to the number of cases and deaths that our inquiries applied as well to those of persons who were subsequently removed to hospitals or elsewhere as to those persons who were taken ill and died in the house, we have no doubt whatever that in many instances hospital cases, as we may term them, escaped our inquiries.

One of our number (Mr. Ludlow) is also afraid that his earlier schedules in particular do not sufficiently distinguish between water-closets and privies with water laid on.

David Fraser.
J. M. Ludlow.
T. Hughes.

Note.—As there is an apparent discrepancy between the number of deaths shewn by the plan of parts of St. James's and St. Anne's, Soho, and those enumerated in the Schedules, it is proper to remember that the information contained in the Schedules was obtained at an earlier period, while the plan shews all the deaths, ascertained, by subsequent inquiries, to have occurred during the continuance of the epidemic. It is believed that the record on the map is as accurate as it is possible to make it, having been prepared with the greatest care from the Registrar General's Returns, from personal inquiries on the spot, subsequently verified by comparing the result of such inquiries with that of investigations made under the direction of the parochial authorities. Since the accompanying report has been printed, Mr. Marshall has discovered, at the Craven Estate Office, the exact position of the pest field. It is delineated on the map, as well as the spot where the Commissioners of Sewers erroneously represented it to have been situated.



25
H N
9
21
148
E
147

—(*Conti*

USE VI

th Septemb

NSTER.—G

Inhabitant

	Employm Habi	…cked.	Observations.
	Carpenters, layers, ta maker.	…se attri- …discharge	The houses in this street are generally stated by the inhabitants to drain into the street sewer, but it is suspected that many of them have only cesspools.
..	..	.. ..	These three houses, and No. 1, are at the south end of the street, and opposite to Nos. 38, 39, 40, 41, and 42; they had all been recently drained with care into the new sewer in the middle of the street, and with the exception of the case of diarrhœa at No. 1, no case of illness whatever had taken place in any of them; the houses themselves were not newer or better in any respect than many other houses in the street. The inhabitants were in the same rank of life; tailors, builders, &c., one Utrecht Velvet importer, &c.
	Tailor, &c.	…kly, aged	
	Straw and manufa…	…es, and a …rank from …street, half …ture.	The deceased used to drink only from the pump in Broad Street, other members of the family occasionally.
in .	Tailor .		
	Tailor, &c.	..	Nothing is known whence the deceased obtained his drinking water. But the family relate, that about six weeks ago, when the pump in Broad Street was repaired, the water which was then used from the pump in Broad Street, turned blueish-black when mixed with pale brandy, an effect not produced with other water. The same thing was observed when water from the same pump was tried again about a fortnight after. The woman affected with diarrhœa drank of this pump.
..	Upholsters	..	No disease, either among inmates or men working in the shop.
	Milkman,	…rd .	Diarrhœa patients drank from Bridle Lane pump.
	Basketma…	…used drank …reet pump …, but after	
	Tailor, &c	. .	The dead one very healthy; drank "quarts" of Broad Street water during illness. The other child improving for the last two days. (N.B. The pump had its handle taken off on the 9th September.)
	Fringe ma… &c.	. .	The occupier supposes that many drains in the street are not trapped. He suggests that a two-inch pipe be carried up each house, for ventilation, above parapet of roof, instead of any gully-holes.
..	Tailor		
	Do.	…ked used to …road Street	
..	Modeller	..	Never drank from Broad Street.
	Tailor .	…tched water …pet while ill.	
	School fo…	..	Never drank from Broad Street.

Particulars as to Persons attacked.	Observations.
...e cholera patient nursed a man who died of cholera in Bridle Lane, and washed his things.	N.B.--A servant is said by neighbours to have been taken away ill; but this may have been either from No. 19, Great Pulteney Street, or 43, Silver Street, as it is denied by the inmates.
...man, age 46, husband of mistress; 1 young woman.	
...woman, age 53, ground floor; 1 man, age 52, sent to hospital.	
...woman, age 32, in back kitchen.	
...oman aged 25. We could not learn whether she had recovered.	
. .. ..	These houses were all reported to be drained into the new sewers, and trapped throughout. They all seemed in a good and wholesome state, and there had been no disease in them, except a few cases of mild diarrhœa (induced by fright.)
...oth the masters, and the the wife of one of them, and the woman who nursed them.	Men were in the house cleansing; the house had not been drained into new sewer.
. .. ..	Could not ascertain whether this house was drained into new sewer.

...e, few inquiries were made, as the size and character of the houses are

D. Fraser.
J. M. Ludlow.
Thos. Hughes.

	Particulars as to Persons attacked.	Observations.
...st	Tailor and wife, aged 60 and upwards, in front attic. Cabman's wife, aged 30, 2d floor.	
	Child of bricklayer, aged 6, a girl (said to have eaten bad fruit in the street).	

II. INHA

Distribution	...s as to Persons Attacked.	OBSERVATIONS.
...hen . . .	...ed 46, 2d floor.	
...nd floor . . .	...ge 50 (diarrhœa ...ight). Boy, age 9.	
" . . .		
" . . .		
...hen . . .	—	
...nd floor . . .		
" . . .		
" . . .		
...particulars were ...ed for rooms wh... happened; they ... parlour . . . ...oor front .	...boy, 12, in back ... Man, 42, child, 8, ... front.	
No particulars obt...	—	
...amilies lived in th... ...he outbreak of ch...	—	
...hen . . .	..., in front kitchen.	
...nd floor . . .		
" . . .		
" . . .		
No particula...	—	

...the exception of one shopkeeper, they were all hand labourers. ...premises are probably in a far cleaner state than common, on accou... ...rnaby Street.

D. FRASER.
J. M. LUDLOW.
THOS. HUGHES.

... COURT

..	...nd a tailor in 1st ...t, adults.	
..	—	
...hen . . .	...young woman in ...oor.	
...nd floor . . .		
" . . .		
" . . (6	—	
...hen . . .		
..	...loor, 1 in parlour.	
..	—	

(WARDOU...

..	—	
..	.. ..	This case was a child of 12, and occurred, not in the house, but in a small two-roomed tenement across the yard, inhabited by 5 persons.
—	—	
—	—	

D. FRASER.
THOS. HUGHES.

...lars as to Persons and Rooms attacked.	Observations.
...ers of the house, age 27; ...r, age 20; housekeeper of ...a Silver Street, age 40, a	
...r, 2d floor, (death said to be ...y excitement).	
•	
...ge 19, a servant girl .	
—	
.. .. ..	These houses were all in fair condition, well supplied with water, and well kept; there had been no symptom of the disease, we were told, in any of them beyond a few cases of mild diarrhœa, generally brought on by anxiety, and lasting only a few hours. There had been, however, one death of a lodger at the back of No. 12 in Carnaby-court.
... 23, on 2d floor; boy, age 13,	
.. .. ..	Houses good and well kept. No disease or death that we could hear of.
...t floor, middle age; girl, ...ld.	
...o butcher, a delicate woman	
...and cabman had each had a ...diarrhœa in their families, ...eath.	
...ge 45, in 2d floor; the tailor ...d floor was lying ill (intem-	
...wife of tailor, in 2d floor, ...ged.	
.. .. ..	Houses good and well kept. No disease or death that we could hear of.
...ofessor, age 50 (eating bad	
...7, 3d floor . . .	

...st side of this street, as their yards, which are small, adjoin the backs of the ... there are cesspools (see our report as to that row), the overflows of which are

...e houses than any of a like description which we have visited. The few ...hing worthy of remark.

Thos. Hughes.
D. Fraser.

ay, 15th Se

BERWICK

No.	No. of Inmates.		...and	OBSERVATIONS.
pu				
	6	..	age; 2d	
	7	..		
	19	..	r back, lly hole	
	18	..	t floor .	
	25	..	oor back oms).	
	25	..		
	5 at out-break, now 30.	..		
	13	..	. .	
	12	..	leath of across	
	10	..		
	9	..		
	7	..		
	10	..	..	These houses, up to No. 22, are, generally speaking, old, and confined at the back; there is a close musty feeling about them, and it is only astonishing that they were so lightly visited.
	23	..		
	26	6 slept		
	9	..	.	See remarks above.
	8	Kitchen Ground 1st floor 2d "	..	See remarks above.
	10	Kitchen Ground 1st floor 2d "	floor; r (two from in the	The kitchen floor, where the milk is kept, remarkably clean and fresh.
	20	This is beds at to mea	..	See remarks above.
	..	..	..	This is a small old house only inhabited by a man (a brass worker) and his wife; they shut it up and went into the country on the first alarm of cholera in the neighbourhood: have since returned.
	10	Kitchen Ground 1st floor 2d "	oor, 10 6, 1st	

...rticulars as to Persons and Rooms attacked.	Observations.
...er, age 50; son, age 18, assistant pawnbroker; butcher's widow, 48, lying ill.	We could not get into this house; the master (a butcher) and his son, had died there, and his widow was lying very dangerously ill. We found, however, that it had no ventilation at the back, being a corner house, quite shut in by its neighbours, and there were two offensive open gratings in the street almost opposite to it.
—	
...as the case of the master printer, 60; he did not live in the house ...t Camden Town; a temperate ...	
... seal engraver, age 45, 1st floor ... temperate); 1 woman, age 50, ...bor, a shirtmaker, and delicate ... days).	
...ise of cholera was a man, age ...t 40, tailor, it had lasted 10 days; ...ras cured. The children had ...liarrhœa.	
...ife of the lodging-house keeper, 40, on ground floor; a delicate ...m.	
—	
—	
—	
...aker, age 25, in 2d floor front; ...iperate man (36 hours ill).	
...rocer, age 28, in 2d floor; had ...ded his brother, at 86, who died.	
.. ..	This house had been shut up for some time and had become a perfect pest-house; there is a cesspool quite full and uncovered in the front area under a privy which has no pan, another apparently under the back yard; the walls are soaked through. Notice to cleanse has, we believe, been given by the parish authorities.
...in, age 50, mother of the green-...r at 33, ground floor, 11 hours ...id to have fallen ill from grief ...iursing.)	
...ter, age 19, 2d floor; getting ...; landlord, ill with cholera for ...'s, recovered.	
—	
—	

No. of Inmates.		...s and	Observations.
12	Kitche... Groun... 1st 2d 3d	40, had a recover-	
6	Kitche... Groun... 1st 2d 3d		
..	..		
14	Kitche... Groun... 1st 2d		
5	Kitche... Groun... 1st 2d	..	It is remarkable that no case happened in this street in any house north of Noel Street, which crosses Berwick Street at this point, except the one at No. 40, and there the patient was brought into the house ill; out of the houses north of Noel Street, therefore (i.e., from No. 45 to No. 67, both inclusive), only four houses have been selected, although inquiries were made at all; the character of all is much the same; they are old, but in fair condition, and occupied generally by people who seemed to be well off.
..	..		
13	Kitche... Groun... 1st 2d	...ught into ...rs.	
13	Kitche... Groun... 1st 2d		
—			
8	Kitche... Groun... 1st 2d		
10	Kitche... Groun... 1st 2d 3d		
12	Kitche... Groun... 1st 2d 3d		
9	Kitche... Groun... 1st 2d 3d		
7	Kitche... Groun... 1st 2d		
12	Kitche... Groun... 1st 2d 3d		
18	Kitche... Groun... 1st 2d		
14	Kitche... Groun... 1st 2d 3d		

...rticulars as to Persons and Rooms attacked.	Observations.
—	
. and his wife in 1st floor.	
n in 2d floor.	
nd child in 3d floor.	
man.	
—	
. kitchen (also one death in a . house across the yard).	
...s of house had attended about ...y cases in the neighbourhood, ...hildren of her own.	
... French polisher, age 50, living ...all room on ground floor across ...ard; wife of mattress maker, ...7, and child, age 11, 3d floor; ...of widow, age 19, recovering, ...oor; young woman lying ill.	
—	

No. of ...tes.	Distri...	Observations.
	—	
	Kitchen Ground floo... 1st floor 2d „ 3d „	
	Kitchen Ground floo... 1st floor 2d „	
	Kitchen Ground floo... 1st floor 2d „	
	Kitchen Ground floo... 1st floor 2d „	
The ...		
	Kitchen Ground floo... 1st floor 2d „	
101,	..	Houses in building, about half finished.
	..	

and ...les, no d... was time ...ome certa... has touch... been ...road

S...grating in the street, smelling very badly. But for th...nall, it is remarkably well kept, and was not over-cr...been reported to us; in some cases the concealment ar...to do more than approximate to the numbers living in...ay, and very many houses are consequently almost de...

...ns and Rooms attacked.	OBSERVATIONS.
...tting well.	
—	
—	
.. ..	These houses were of the same character, not so crowded as No. 15, old, but in fair order. There had been no disease in any of them, unless some cases of diarrhœa, which were recovered. (We find it very hard to obtain information as to disease which has not been very serious.)
...an, in 1st floor front.	
...or. ...oor, a strong man. ...ild ill of diarrhœa.	
...l in hospital). ... back room.	
... to another house.	
...4, in back parlour. ...nt attic. ...he kitchens had had diarrhœa.	
...oor front, ill 8 hours. ...loor back, ill 1 day. ...round floor, recovering. ...ft.	
...and died there)— ...loor back, 2 days. ...st floor back, 6 days. ...oor front, 6 days. ... 3d floor.	
...d floor.	
...ler 30, 2d floor. ...ered.	
...ht in ill, recovering, his parents died ...et.	
...2d floor back, a strong person.	
...	
..., cholera 2 days, consecutive fever	

INHABITANTS.

OBSERVATIONS.

Si No.	tion.	
	M. W. CH.	
	1 – 1	Publi
	2 1 3	
	1 1 2	..
	1 1 1	
	1 1 2	Shoe
	2 2 1	
	1 1 1	
	– 1 –	..
	1 1 2	Cap
	2 2 7	
	2 3 –	
	2 1 2	

D. FRASER.
THOS. HUGHES.

SOUTH RO

OBSERVATIONS.

Sit No.	No. of Inmates.	Attacks.
	13	t, ill of at the g better.
	12	diarrhœa, ure could rties had pital. *Pr...*
	25	ing ill of rhœa in
		Th...
	14	ng ill of rhœa in *...re sup- ...ft from*
	at the out- of cholera."	

III. Disease.		Observations.
s as to Deaths.	Particulars as to Attacks.	
14 years old, 2d rs old, 2d floor. s old, 3d floor.	*Some cases of diarrhœa cured; particulars not discovered.*	
years old, wife of , slept in parlour. pt in 1st floor.	No illness reported.	

ve could gather nothing from their statements. Many of the occupants of the laying down of the new sewer, particularly a shoemaker on the ground floor of (ineffectually) with a piece of oilcloth and stones.

We heard of very little drunkenness; no case of cholera was traceable to it.

e first day of the outbreak.

D. Fraser.
Thos. Hughes.

ve in the kitchens under ground and close to the privies, where the smells both only two have taken place in the kitchens, while seven have taken place in the one only on the ground floor. As a rule the occupier of the house lives on the rs; but the lodgers in the kitchens and the 3d floors seemed to be much in the at better off than the others. There seemed to be no very distressing poverty in the kitchen of No. 3.

the above Table, which relates to the houses, we must warn the Board that the at work, others had left temporarily from fear, and the minds of those we saw cur information from persons whose friends and relations were scarcely yet it we had to take our chance as to the intelligence of those of the inmates who

(Signed) D. Fraser.
Thos. Hughes.

E-TO-HOUSE VISITATION.

Monday, 11th September 1854.

SILVER STREET.

	II. Inhabitants.		Cholera.		Diarrhœa.	
Complaints of utward Nuisances.	No. of Inmates.	Employments and Habits.	Cases.	Deaths.	Cases.	D
.. ..	4	Confectioners .	1 taken away and improving.	..	..	
.. ..	6	.. .. ..	1	1	..	
.. ..	.. ..	Coffee-house . .	..	No disease.		
ully-holes in Cambridge Street and Silver Street.	5	Bakers . .	2	2	..	
ully-hole corner of Silver Street.	7	Cook-shop . .	3 1 recovered	2 1 taken away.	..	
ormerly cartridge factory at back, but not for last month.	8	Stationers . .	4 2 recovered, 1 recovering.	1	..	
ery bad smells since new sewer.	12	Tobacconist . .	3	1	..	
.. .. ..	8	Publican . .	1	1	..	
mells from new sewer, and smoke from cartridge factory at back.	10 or 11	Butcher . .	..	..	2	
.. .. ..	7 to 8	Publican . .	..	..	1	

...c.	General Remarks, &c.
..	All five slept in the attic whilst the person lay dead, but none were affected by it.
.	A man in the house has particularly surveyed the neighbourhood, and he found that the mortality was always very great in houses facing gully-holes; likewise a man drank copiously of the Broad Street pump-water at the time he had diarrhœa, and he attributes his cure to it *entirely*; if he had not done so, he thinks he should have died.
..	14 and 15 have been previously tabulated, the tripe dresser at No. 14 states that no smells have been perceived since the bakehouse was established next door; he inquired all over London, and affirms that no tripe dresser was attacked.
..	No deaths westward of Carnaby Street.

NTILATION, &c. n. tate of the Premises. of External Nuisances.	CHOLERA. a, Cases. b, Where. c, Occupation. d, Number sleeping in Room at the Time of Attack. e, After Death.	DEATHS, &c.	
d. c, occasionally the drain	.. .. ..	.. .. ..	.
l	.. .. ..	.. .. ..	.
. . . . .	—	—	
od. c, smells from drains; he drains in next house, No. 31.	a, 1 case. b, 1st floor. c, a bookbinder.	Died out of the house in Knowles Street .	A
d	—	—	
. . . . .	—	—	
. . . . .	—	—	
. . . . .	a, 1 case. b, 3d floor front. c, grocer's wife. d, 2 slept in the room.	Died . . .	2
. . . . .	a, 1 case. b, 1st floor front. c, greengrocer's wife. d, 2 slept in the room.	Recovered . . .	
l. c, complains of bad smells r used in boiling greens, &c., the lower part of the house; utter which passes under his bad smells from a drain in use.	.. ..	.. .. ..	
l. c, complains of bad smells as.	a, 1 case. b, 2d floor. c, a bookbinder's wife	Died . . .	
. c, complains of bad smells -holes in front of the house.	a, 1 case. b, 1st floor front. c, a domestic.	Died at Charing Cross Hospital.	
. . . .	—	—	
l. c, bad smells from drains.	—	—	
. . . .	—	—	
. . . .	—	—	
.. ..	.. ..	.. .. ..	

nd the table prepared by a medical student who assisted on the occasion.

Particulars to Persons attacked.	Observations.
: but children on the :mises, from whom no ormation obtainable; t one person lying ill.	
deceased were children, o of them the land- d's; the whole family four occupying two oms, and having been The third was the ld of a painter, who s also ill.	
lor, well conducted.	
—	
ased a porter, sober l healthy; complained smell from clothes be- ging to dead person osite, put out to dry the leads; became rmed; was taken ill at f-past 8 a.m., and died f-past 1 p.m., same r.	
y, scn of a tailoress.	
lor; sober.	
man and two children, en to the hospital; et sober people; the er a carpenter's ap- ntice, aged 16.	
, bootmaker; carried workhouse; one child d, one recovering.	
woman, landlady, a nkard; one man, shoe- ker, sober. Woman nk Saturday night, d Monday.	
an, a japanner; sober.	
otmaker, his wife, and child of 3. Very re- ctable, but poor; could er taste meat.	The woman attended on a man who was ill of cholera in Wardour Street; the man took fright, but worked himself to death to maintain his family.
--	
olsterers, very steady.	
, the landlord.	

ral State of remises.	Complaints of Outward Nuisances.	II. INHABITANTS. No. of Inmates.	Employments and Habits.	Cholera. Cases.	Deaths.	Di Cases.
.	.. .. ..	30	Envelope makers, shoemakers, bricklayers, painters, &c.	1	1	3
. .	.. .. ..	30	Painters, &c. . .	8	7	Almost every inmate
. .	Smell from sink in court opposite.	12	Builder . .	2	2 (one taken away).	..
. .	.. .. ..	10	Mangle kept . .	3	2	..
. .	.. .. ..	15	School . .	1	1	..
..	Sink at west end of court.	.. ..	Broker . .	No disease, but an old person died from "fatigue."		
.. ..	.. .. ..	.. ..	Herbalist . .	..	No disease.	
Good	.. .. ..	21	Coffee shop . .	1 (taken to workhouse)	1	..
	ST. ANN'S PLACE.					
ent. Rubbish staircase to shop above; ed since dis- broke out.	.. .. ..	10	Milk people, oyster sellers, &c. .	5	(?) 5, 3 taken away.	..
.. ..	.. .. ..	.. ..	.. .. ..	..	No disease.	
	SWAN ALLEY.					
.. ..	.. .. ..	7	Bootcloser . .	1	1	..
.. ..	.. .. ..	.. ..	.. .. ..	..	No disease.	

ed, by a sewer through the centre spools. Many of them are over- l in drinking is mostly taken from

the premises, but the habits of many of the inmates class. It is suggested by the schoolmaster at No. 2

St. Ann's Place opens out from St Anne's C and probably the latter, which seems to have been

Situation and No. of Houses attacked.	OBSERVATIONS.
1 (north side	
2 and 3, (north and south side.	
4 (south side.	

Pew'his is, that any filth thrown in at the sink, and possibly end beingted to be often very thick, and is indeed visibly impure, The drain
have any vith water laid on, and a closet of its own, have been a fortnighare easily accounted for by the bad quality of the pump by the cothe sink.
of the cou

J. M. LUDLOW.

1 to 5 (ea side); 6-1 Broadwoo workshop &c.; and c west si from No. exclusivel southward	..	A sewer, running into Brewer Street, is carried up as far as opposite No. 2. One house drains into a dunghole in the lane, not emptied since last winter. An open surface drain runs down the upper part of the lane.
14, (east side.)	3 years .	Stables below.
15	..	Stables below. A case of nervous fever from fright.
16	..	Back premises of house in Great Pulteney Street. No entrance open in lane.
17		
18	20; the one . recovered, or in hos-	
19, (west side.)	laughter 8 man not iarrhœa on became ill ening, died ing.	

The ds been very trifling, and confined to the Silver Street or or cistern.

THOMAS HUGHES.
D. FRASER.
J. M. LUDLOW.

riday, 15th September 1854.

ESTMINSTER.—NOEL STREET, PORTLAND STREET.

	II. Inhabitants.					
ints of Nuisances.	No. of Inmates.	Employments and Habits.	Cholera. Cases.	Cholera. Deaths.	Diarrhœa Cases.	D
..	4, 73 workers.	Bookbinder . .	3; 5 workers. 2 recovering	3; 3 workers.	..	
..	About 20.	Cabinet - maker, washerwoman, &c.	..	..	5 slight; recovered.	
..	.. ..	.. .. ..	..	No disease.		
rom next hich seems ow in front	27	Bootmaker . .	1	1	..	

exclusively
ner appears
both by the

inmates, and by a person from next door who laid out the
of the workshops.

PORTLAND STREET.

..	.. ..	.. .. ..	..	No disease.		
..	.. ..	.. .. ..	1	1	..	
of effects to the sick removed.	27, and 2 in back tenement.	Cheesemonger, gold-beater, &c.	4	2 in hospital	..	
nplains of nt up by thorities.	.. ..	Publican, &c. .	..	No disease.		
ide No. 8, sive when n the east ell fills the	13 or 14, and 7 or 8 work-people.	Pipe-makers . .	2; 1 recovered 1 mending	..	1 worker, slight.	
..	.. ..	.. .. ..	..	No disease.		
.	26, and 1 in cottage at back.	Painter and glazier, &c.	2	2	1	
..	.. ..	.. .. ..	..	No disease.		
..	22	Tinplate worker, &c.	2	1	1	
..	.. ..	.. .. ..	..	No disease.		
..	.. ..	.. .. ..	1	1	..	
..	10	Joiner, &c. . .	1	1	..	
..	9	Milkman, &c. .	1	1	..	
..	7	Butcher . .	3 1 dying of secondary fever.	2	..	

. A public
complained
is from the

eastward, so that he cannot stand at his door, and the unhe
nuisance in its present situation is the more surprising, as t

Particulars ɔ Persons attacked.	Observations.
ʀ man, tailor, given to k, and subject to diar- ı; young woman, very ·ous, kept school, and much alarmed.	
ın, 42, housekeeper niece to landlord.	
's wife with 6 chil- ; 8 persons in one ı, 12 on the floor; well .ucted.	
aged 22; taken ill ay morning, died in ɔvening.	
ın, tailoress . .	N.B.—There was a good deal of diarrhœa in the house sometime before the outbreak.
and woman, aged 40 30; the man was h alarmed (the ler).	
's wife, young girl, ·ldeı ly woman; shoe- er, his wife, and 2 lren; well conducted, 6 in one room, of m 4 died. Girl on 1st died of fright.	
ɔrwoman, very poor; it seems doubtful ther she died of ty- ·, cholera, or a bad st.	
ɔrd's mother-in-law, l 80; tailor and 2 boys.	
ed woman.	
— —	
girl.	

ıses are respectable, but often in bad condition; a frequent cause ·lls to the upper floors.

.. ..	A room over stables.
.. ..	Stables, warehouses, &c., or backs of houses in adjoining streets.
—	
ın and child, gallery; · died, and wife re- ·ed, ground floor; cab- ılead, and wife ill, ditto.	6 in one room.

ter is complained of as very bad, the filth apparently percolating · from this source of infection.

D. Fraser.
J. M. Ludlow.

Monday, 18*th September* 1854.

PARISH OF ST. JAMES, WESTMINSTER.—BROAD STREET, NORTH SID

		II. Inhabitants.		Cholera.	
General State of Premises.	Complaints of Outward Nuisances.	No. of Inmates.	Employments and Habits.	Cases.	D
.. ..	.. .. ..	.. ..	Baker . . .	..	
.. ..	.. .. ..	.. ..	.. .. ..	..	
k offensive in front itchen; otherwise good.	A drain from the next house, running next a back room on the ground floor, which requires the constant use of chloride of lime.	34	Baker, &c. . .	9	
e dust, which has been ince cleared, smelt very ffensive on Friday, st September, and here was a very bad mell on landing place.	.. .. ..	26	Tobacconist, tailor, &c.	4	
od . . .	.. .. ..	33	Newsvender, &c. .	4, 1 in hospital, recovering	1 in . ta
Do. . . .	Sink in street, trapped during cholera week.	20	.. .. ..	2, 1 recovering.	
Do. . . .	.. .. ..	10	Lodging-house keeper, &c.	2, 1 recovering.	but ill work of h
l; lime-whited twice is year.	Sink in street, opposite No. 5, so offensive on Monday, 28th August, that windows at No. 8 had to be closed. Cesspool at No. 9, Bentinck Street, most offensive in workshop behind No. 7; the windows sometimes have to be closed. The same is the case with the nursery windows behind No. 9.	At No. 9, 6 inmates; 42 workers in all.	Artificial tooth-maker	4, of workers 1 inmate, 5 workers	of wc No d 5 wo take here died their hon
.. ..	Gully-hole opposite corner of Poland Street.	22	Gunsmith, tailor, &c.	2	1
. . .	.. .. ..	11	Timber merchant .	3	1
.. ..	.. .. ..	More than 20	Funeral furnisher, &c.	4	4
.. ..	Corner gully-holes in Broad Street and Poland Street.	.. ..	Furnishing undertaker.	..	N
in yard . .	Very bad smells on Saturday, 2d September.	20	Milliner, &c. . .	2, recovering	..
y communicates with that of a tailor in Poland et, and is sometimes offensive; the closet of a lic house in Poland Street drains also through yard well, and is often very offensive.		8	Italian warehouseman	1	1
.. ..	.. .. ..	About 20 .	Artificial flower maker, frame makers, school, &c.	4 1 in hospital.	4
.. ..	.. .. ..	18, and 7 workers	.. .. ..	3	2, 1 out hous

No.

Observations.

D. Fraser.
J. M. Ludlow.

The occupier of No. 25 states that disease has followed the course of the new sewer, brought within the last 20 months from Tyler Street, by Marshall Street, into Broad Street, thence into Windmill Street.

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an;
eted
ker;

rds.
40;
such
alled
died

The diarrhœa cases recovered; drinking a great deal of pump water.

	II. Inhabitants.					
Complaints of ...tward Nuisances.	No. of Inmates.	Employments and Habits.	Cholera. Cases.	Cholera. Deaths.	Diarrhœa. Cases.	Diarrhœa. De...
.. ..	20	Tailor, &c. . .	7 (2 taken to hospital.)	5 (1 in hospital.)	..	
.. ..	.. ..	.. .. ..	1 (man living on premises.)	Recovered	..	
.. ..	19	Haberdasher, &c. .	5	3	..	.
...mells from street .	19 or 20	Carpenter, &c. .	5	5 (1 away.)	..	.
from Cambridge ...t, through which slops sent down.	50	Tailors, &c. . .	7	5 (2 in hospital.)	..	.
.. ..	15	Dyer and cleaner, &c.	3	2	..	.
...hole opposite in ...	26	Lodging-house .	2	2	2	..
.. ..	29	Carpenters and builders, &c.	2	2	..	..
.. ..	26	Carpenters and builders, &c.	6	6	..	..
.. ..	.. ..	Brewery .. .	No disease, cholera or diarrhœa; 20 men employed.			
...ll in New Street used as conve-...	9	Watercloset maker, &c.	1, recovered.	1	..	..
.. ..	23	Trimming seller, &c.	2	2	..	..
.. ..	11	Grocer, &c. . .	3	1	..	..
.. ..	19	Cheesemonger, &c. .	2	1	1	..

...oth extremities
It is supplied,
...abitants drink
...he south side.
...sances will be
...1, (4 deaths).

That at Nos. 8 and 9 from the cesspool behind No. 9, Benti... looked. The exemption from disease of Nos. 1, 2, 13, 21, ... equally be remarked.

Great difficulty was experienced at several houses in obt... dition of reporting an alleged neglect by one of the medical ...

articulars ·rsons attacked.	Observations.
—	
›, daughter, and rson; porter.	The occupier recollects bones being taken out when sewer made in Silver Street.
tress, of nervous ·ment, took fright on hearing of ur's death.	
—	
—	
—	
ife; cloakmaker's .	The landlord, the publican at No. 7, will do nothing for the premises.
ıan . . .	
—	
woman, assistant vant.	
ı, man-cook of n and child, 2 at makers, charr- dying; all well ed.	The landlord, owner and occupier of No. 5, will do nothing for the premises.
. .	
man who slept 3 n the house when but died away.	
assistant.	
ıan, aged, over- , and ill-fed, re- from house with a, died in hospital ra.	
—	

·glected by the landlord, and the cesspool underneath it makes he occupiers are afraid to take any steps themselves which rities taking the matter in hand, and compelling the owners

J. M. Ludlow.
D. Fraser.

Situation and No. of House.	No. of Rooms.	Water. Source of Supply.	W	Whether worse d the Ni or before C the Hou Shop the Mor
51 (west side).	12, besides kitchens	Grand Junction Co. .	From wh all St	. .
52	.. ..	Do. . . .	Pres	
53	? 12 or 13	Do. . . .	Pun	Smells wor evening, they cle slaughte
54 (west side).	.. ..	Do. . .	Pre	
55	15, including kitchens.	Do. . . .	Pur as fo	. .
56	13, including kitchens.	.. .. ..	But	
57	12, besides kitchens.	Grand Junction Co. ; cistern and butts.	Pre n B se o	
58	.. ..	.. .. ..	..	Just took cartload dung th ing.
59	14, including kitchens.	Grand Junction Co. .	Bu n	

. .

. .

At time evenin

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·iculars ons attacked.	OBSERVATIONS.
wife, and child, y temperate artic onducted. rsor	
a, di rson	
and son. tress men on ur's	
r, was alarmed.	
, husband, and conducted.	
ife; fe.	
ian	
46, not cleanly, at nights; car- wom ife, sickly, had vant. had two mis-	

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D. FRASER.
J. M. LUDLOW.

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T. JAMES, WESTMINSTER—MARSHALL STREET, GOLDEN SQUARE.

Dustbin.		General State of Buildings.		
How often emptied.	If offensive before the Outbreak of Cholera.	General State of Premises.	Complaints of External Nuisances, Gully Holes, &c.	Whether worse d[…] the Ni[…] or before C[…] the Hou[…] Shop the Mor[…]
Was found empty when workmen came.	- - -	Bad - -	Cannot be answered, inasmuch as there is no one in house.	- -
Frequently	Not offensive -	Tolerably good	Slaughter-house in front smells *so bad* that they cannot keep the windows open.	Smells wor[…] evening, they cle[…] slaughte[…]
Frequently	Not offensive -	Tolerably fair	The slaughter-house smells so bad from 4 to 5 in the morning, that the inmates are obliged to close their windows; also during the summer they were often obliged to shut the *shop door* in the day.	- -
Frequently	Not offensive -	Very good -	Witness does not like to speak of nuisances for fear of displeasing the landlord.	Just took cartload dung th[…] ing.
Frequently	Not offensive -	Very fair -	When the wind is westward it blows the noisome smell from the slaughter-house upon these premises. This witness has the same complaint as the previous one as to the dung; the sour brewing is said by the workmen to come so thick as to be capable of cutting.	- -
Frequently	Not offensive -	Good - -	Witness complains of the slaughter-house in front of the house.	- -
Frequently	Not offensive -	Good.	—	-
Frequently	Smells occasionally when emptied, and this *previous* to the outbreak of cholera in the district.	Good - -	Complains of bad smells from the grating in front.	At time[…] evenin[…]
Frequently	Smells when emptied.	Good - -	Complains of bad smells from the grating in the front, and from the slaughter-house.	-

	Diarrhœa.		General Remarks.
eaths.	Cases.	Deaths.	Structural Peculiarities of the Street as regards Ventilation, whether Cases are more numerous opposite Gully Gratings, &c.
died.	—	—	
lied; one vered.	—	—	
ree died	—	—	
- -	14 cases, *all from fright:*	All recovered.	
ur died -	—	—	
—	—	—	
person in Broad t.	—	—	
—	—	—	Four persons are said to have died of cholera in this house.
- -	A painter in 3rd floor back room.	Recovered.	
—	—	—	
—	—	—	
- -	2 cases on the 1st floor.	Recovered -	The patient that suffered from cholera had bathed whilst heated.
- -	A bricklayer.	Recovered.	
—	—	—	

	General State of Buildings.				
…nsive before Outbreak of Cholera.	General State of Premises.	Complaints of External Nuisances, Gully Holes, &c.	Whether Smells worse during the Night, or before Opening the House or Shop in the Morning.	Cases.	What Part of the House.
…ffensive.	—	—	—	—	—
…ffensive	Good.	—	—	—	—
…ffensive	Good.	—	—	—	—
…ffensive	Good.	—	—	—	—
…ffensive	Good	-	-	-	-
…ffensive	Good	Complains of a large and open dust hole belonging to the next house.	—	—	—
…ffensive	Good.	—	—	—	—
…ffensive	Good.	—	—	—	—
…ffensive	Good	-	-	2	2d floor front
…ffensive	Good	-	-	-	-
…ffensive	Good	-	-	-	-
…ffensive	Good	Complains of a bad smell from the drain hole in area close by the water butt.	-	1	1st floor back
…ffensive	Good.	—	—	—	—
-	Good	-	-	3	One in 3d floor front, another in 3d floor back, and a third in 2d floor front.
-	Was very bad, but being lately done up, is much better.	—	—	—	—
-	Good	-	-	1 case, a servant *out* of the house.	-

	Diarrhœa.		General Remarks.
Deaths.	Cases.	Deaths.	Structural Peculiarities of the Street as regards Ventilation, whether Cases are more numerous opposite Gully Gratings, &c.
Two former died; the 3d recovered.	—	—	
Shirt maker died at Middlesex Hospital; all the four children died.	A female had diarrhœa.	Recovered.	
The man died; the servant died at Middlesex Hospital; the charwoman died at the Free Hospital.	A little boy on 2d floor.	Recovered.	
Recovered.	—	—	
Died - -	Bootmaker and his wife had diarrhœa.	Both recovered.	
- - -	A woman on 2d floor.	Recovered.	
Died.	—	—	
- - -	A lastmaker had diarrhœa.	Recovered.	
Recovered -	An old woman, 1st floor front, had diarrhœa.	Died therefrom.	
—	—	—	

DATE DUE

Farr III	MAY 15 1962